

THURSDAY, JUNE 15, 1876

BRITISH MANUFACTURING INDUSTRIES

British Manufacturing Industries. By Various Authors. Edited by G. Phillips Bevan. (London: Edward Stanford.)

IN this series we have presented to us an account of the origin and development of those industries which have given this country her pre-eminence among nations. As stated by the editor, the object of the various treatises is simple and unambitious; no attempt is made to render them technical guides to the industries to which they relate; the main idea is to give, in as readable a form as is compatible with accuracy and a freedom from superficiality, the main features and present position of the leading industries of the kingdom, so as to enable general readers to comprehend the enormous growth of the last quarter of a century. The editor has been singularly fortunate in the selection of his co-operators. For example, Prof. Warrington Smyth tells us all about the mines and collieries of the country; Prof. Hull discourses on quarries and building stones; Capt. Bedford Pim on shipbuilding; Mr. Mattieu Williams finds congenial themes in iron and steel, gunpowder and explosives. The article on cotton by Mr. Isaac Watts, the Secretary of the Cotton Supply Association, is remarkably full and complete; Mr. Felkin's little treatise on hosiery and lace is a perfect mine of information, and forms a most interesting record of perseverance and effective skill; the stories of Jedediah Strutt and John Heathcoat will ever be two of the most thrilling chapters in the history of the industrial progress of this country. Indeed this series might have been fitly called the Romance of British Industry. We are told of Lee and the stocking-frame; of Wedgwood and Herbert Minton; of Hargreaves, Arkwright, and Crompton; of Dud Dudley and poor Cort; and of numbers of others, whose peaceful victories have done more for this country than all the machinations of her statesmen or the valour of her armies. *Apropos* of the invention of the stocking-frame it may be remarked that Elmore's well-known picture, representing Lee, after his expulsion from his college, intently watching the lissom fingers of his wife as she knits for the support of the household, in order that he might imitate their motion, is founded on a myth. Lee was a decent country curate in easy circumstances; he was never married, nor was he expelled from his college. But little is known of his history, beyond that, becoming greatly discouraged with the reception of his invention in this country, he passed over to France, where he died, neglected and in misery, in 1610. The history of the improvement of the stocking-frame is not less interesting than that of its origin. Since the time of Strutt, nearly 300 changes and adaptations have been patented, the vast majority of which are due to men who commenced life at the forge or bench, or at the frame itself.

The history of the rise and development of the lace manufacture is scarcely less remarkable, and Mr. Felkin has much to say concerning the personal history of its founders and of the trials and struggles of the inventors and improvers of lace-making machinery. Few trades have probably given rise to such an amount of litigation:

indeed one can have no real conception of the immensity of the barrister's theme, or how eloquent he must have seemed to the beaver when—

"he proceeded to cite
A number of cases where the making of laces
Had proved an infringement of right."

until he has read this essay. The story is painfully sad, and its moral is not lost on Mr. Felkin. "We cannot but remark," he says, "the extraordinary amount of latent inventive skill brought into operation by men entirely uninstructed in the science of mechanics; and be struck with the time and thought that the knowledge of sound mechanical principles would have saved them. . . . It is painful to notice how many of these men, possessing fine natural talents, from the want of self-government failed to use aright even the measure of profit that reached them. . . . Genius was to them rather a curse than a blessing. Here are strong arguments for higher scientific and moral education to be placed within reach of these classes."

Mr. Mattieu Williams concludes his capital little treatise on steel with a similar reflection. He indignantly protests against the fallacy of attributing our industrial success to coal or iron-stone, or to any other mere mineralogical or geographical accident. "It is not British minerals, but British industrial energy which has given us our industrial supremacy. It is not true that we are so exceptionally rich in coal. Many other nations possess vastly greater stores than ours; but while theirs has lain buried under their feet, ours has been brought to the surface and wonderfully used; to such an extent indeed, that we are actually approaching the limits of our supply before other and older people have tapped theirs. . . . The same energies which have thus seized upon and utilised the rudest source of power to supply the coarser wants of ourselves and the rest of mankind, will if properly directed, similarly turn to account the more refined and recondite energies of nature which science is revealing, and which will supply in like manner the higher wants of more advanced civilisation. To succeed in this we must prepare at once, by affording to all classes the largest attainable amount of knowledge of the raw materials and powers of nature; of human means of turning these to profitable account; of the social organisation in the midst of which we live, and by which we are to co-operate industrially with each other and all the peoples of the earth; and above all, of the individual moral qualities, habits, and attainments that are necessary for each man's industrial success."

It is because other nations are actually turning to account "the more refined and recondite energies of nature" that our industrial supremacy is threatened. In chemical manufacturing, for example, the pre-eminence of the alkali trade belongs to us, but, as Prof. Church tells us, German, Austrian, and French manufacturers are far ahead of us in the production of the finer and more delicate preparations of the chemist, and still continue to make remarkable progress. "If a rare and curious substance, discovered by a scientific chemist and made in his laboratory painfully grain by grain, be found useful in medicine or dyeing, or some other art, straightway the foreign manufacturing chemist makes it, not by the ounce or pound merely, but by the hundredweight or

even by the ton." Much of the crude material which yields these beautiful and costly products of the continental manufactories is exported from England to be worked up and reimported. The reason of this lies in the more intimate union of science and manufactures which prevails abroad. The chemical manufacturer on the continent finds it to his interest to attach a sound and properly-trained chemist to his works to improve the established methods of production and to seek to discover new processes.

With the space at our disposal it is impossible to do more than merely indicate the scope and character of this series of excellent treatises. There are one or two little matters which need revision, and which the editor will doubtless set right in future editions: for example, the combining proportion of tin is not usually stated as 58, nor that of zinc as 32.6. Perhaps the most serious drawback is the very sparing use of illustrations. When given they are generally very good; nothing could exceed the beauty and finish of the cuts accompanying Mr. Watts' article on cotton. We are sorry that the example thus set has not been more generally followed. T.

HUTTON'S "GEOLOGY OF OTAGO"

Report on the Geology and Gold-fields of Otago. By F. W. Hutton, F.G.S., Provincial Geologist, and G. H. F. Ulrich, F.G.S., &c. (Dunedin: Mills, Dick, and Co.; London: Sampson Low and Co., 1876.)

THE Southern Province of New Zealand is one of great interest from the variety of its physical features which faithfully indicate the wide range of geological formations of which it is built up. The snow-clad ridge of "The Southern Alps," with numerous pointed peaks and serrated ridges, runs along the western coast, and is penetrated by deep "sounds," or fiords, not unlike some of those on the west coast of Norway. Mount Aspiring, at the northern border of the province, reaches an elevation of 9,940 feet, while several other points rise upwards of 8,000 feet above the sea, forming altogether a grand background, from which the rest of the country descends towards the eastern coast in a series of rolling downs, diversified by deep valleys and numerous lakes. The rivers are remarkable for, in several cases, and with much perversity, cutting through ridges, and crossing the boundaries of the formations, in a way that not long ago would have been attributed to the effects of mighty "convulsions of Nature," but which the physical geologist is now able to account for on very different principles. The Southern Alps contain glaciers which, as Mr. Hutton shows very clearly, extended considerably beyond their present bounds on two occasions in later Tertiary times, and to this agency he refers the excavation of the rock basins which now constitute nearly all the lakes of the hilly districts. An excellent view of this chain of snowy mountains will be found in Dr. von Hochstetter's elaborate work on New Zealand; in which Mount Cook, Mount Tasman, and the adjacent mountain giants are seen towering to an elevation of 13,200 feet above the waters of the ocean.

The work before us is a very carefully prepared, and scrupulously accurate, report on the physical features and geological structure of the district of Otago which, under

the direction of Dr. Hector, the author has explored and mapped. The arrangement of the matter is good, and the descriptions succinct, while the writer is careful to notice the labours of others in the same field of research. The roughness of some of the woodcut illustrations, which one cannot fail to notice, is perhaps inseparable from a work brought out in a young colony, and is not to be laid to the charge of the author.

As already observed, the geological formations of Otago have a wide range in time, extending from the crystalline masses of the New Zealand Alps (possibly referable to the Laurentian period) through the representatives of the Lower Silurian, Carboniferous, Triassic, Jurassic, Cretaceous, and Tertiary times down to the present day. The thickness of some of these older formations is doubtless very great, but the difficulty which the author feels in estimating the apparent thickness of some of these formations at the amount deduced from the dip of the beds may probably be overcome by supposing that the beds are folded over on themselves—a phenomenon of very common occurrence in such districts as that of the New Zealand Alps. The Otago formations have very properly received names derived from localities where they are well represented. The reference to the equivalent formations in Europe is given with some hesitation; nevertheless, it cannot be doubted that on the whole these determinations are substantially correct—even if we suppose a relative, rather than an absolute, synchronism owing to the vast intervening space between Europe and New Zealand; and for all purposes of comparison it is not of the slightest importance whether it is one or the other.

The great oscillations of level through which New Zealand has passed are well described and illustrated by Mr. Hutton under the head of "Historical Geology." These correspond to some extent with the movements which in Britain and Europe have enabled us to define the limits of the three great divisions of geological time. Towards the close of the Palæozoic period "New Zealand probably formed a subordinate part of a large continent, which, judging by the similarity of the shells and plants, joined in the following formations with those of Australia, India, and Europe, probably stretched far away to the northward" (p. 75).

At the commencement of the Triassic period this continent began in New Zealand to be submerged; and with one or more slight oscillations this subsidence continued till towards the middle of the Jurassic period, when the whole country was again elevated, and the chain of the New Zealand Alps was formed. Great denudation of the upraised beds ensued, as they remained exposed to the atmosphere till the later Cretaceous period. Hence the unconformity between the Upper Cretaceous and the Lower Jurassic rocks (the Warpara and Putataka formations), and the entire absence of the intervening strata. Since the great upheaval here referred to, the New Zealand Alps have never been totally submerged, though sometimes deeply depressed.

The Upper Cretaceous period was one of submergence to all but the higher elevations, and at its close there was another elevation, accompanied by disturbances of the strata, resulting in an unconformity between the Tertiary beds and all those of older date. These former are found

filling in the depressions and old valleys of the Mesozoic and Palaeozoic rocks, and often containing valuable beds of lignite resulting from the decay of the vegetation which found a congenial soil and climate amongst the lakes and lagoons of the period.

Mr. Hutton considers that there was a "Glacier period" during older Pliocene times, and another of less importance just before the Pleistocene epoch. Both of these are of earlier date than "The Glacial period" of the northern hemisphere, and in the view of the author, as well as of Dr. von Hochstetter and Dr. Haast,¹ were due not to climatical influences extending over the southern hemisphere and differing from those of the present day, but solely to the greater elevation of the land in New Zealand at those periods, and the consequent extension of snow and ice over a larger area than at present.

In Mr. Hutton, "The Theory of the Glacial Origin of Lakes," at least as far as it applies to the province of Otago, finds a new and welcome advocate; and his observations on this question are opportune at this time, as Prof. Ramsay's theory has been challenged by an able writer in the pages of the *Geological Magazine*.² Mr. Hutton first examines the views of those who have referred the origin of these lakes in Otago to subsidences, or terrestrial movements, and considering them inadequate, falls back on that of glacial erosion, in support of which he can appeal to the evidence of former glacial action along the shores of the lakes themselves.

The latter portion of the volume before us is taken up with the report of Mr. Ulrich upon the gold-fields of Otago, which is of much local interest, and will doubtless prove of value in guiding future adventurers, but does not appear to call for special observation in a short review.

OUR BOOK SHELF

Elementary Algebra, with Numerous Exercises, for Use in Higher and Middle-class Schools. By David Munn, F.R.S.E. (Collins' School Series, 1876.)

THE chief justification, perhaps, for the production of this work is that the exigencies of a "school series" demanded the publication of an elementary algebra. There is not much more in it than is to be found in a half-dozen similar works, and the explanations of rules seem to us to fall short of those given elsewhere. We do not like the frequent use of *evidently* in an elementary work; our own extended experience with English school-boys is that these elementary details are by no means evident to the ordinary schoolboy mind. On p. 70 "the L.C.M. of a^2b^2c and $a^2b^2c^2$ will evidently be $a^2b^2c^2$ " is evidently wrong, for it evidently ought to be $a^2b^2c^3$. Art. 8 on p. 45 (to show that when a certain algebraical polynomial is divided by $(x-a)$, the remainder is what the polynomial becomes when in it x is changed to a) is useful, and we teach it to advanced pupils, but we are disposed to think that few beginners could grasp the truth and apply it. On pp. 173 to 176 we have some interesting *Miscellaneous Propositions* on the progressions which we do not remember to have seen in previous textbooks. The most important mistakes we have found are on pp. 66, 96, 107, 151, 153. Here we may remark that there is a very plentiful crop of typographical blunders; many of these we are disposed to attribute to a hasty

examination of the "proofs;" frequent instances, too, occur in which 2, 3, or 5 have got interchanged. There is a large collection of exercises, but happily no answers are given at the end, or the list of errata would doubtless have been greatly enlarged. From the fact that $(a^m)^n = (a^n)^m$ for positive integers, "it follows that $(a^q)^q = a^p$." This, we think, will hardly be admitted; we should prefer to assume that the result holds, and thence derive an interpretation of $a^{\frac{p}{q}}$. The book takes in Indeterminate Equations, Permutations, Ratio, Proportion, Variation, and the Binomial Theorem. The only Scoticism we have noticed is one that frequently occurs: it is, "we will find," &c.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

The Early History of Magnetism

PERMIT me to supplement "K.'s" excellent sketch of the "History of Magnetism" (NATURE, vol. xiii. p. 523) by two notices of the "Mariner's Compass," which seem to be of earlier date than any hitherto found in Europe. They possess particular interest from showing the compass in so rude a state as to lead to the inference that we owe it to a re-discovery rather than to an importation from China. The author of the notices is Alexander Neckam, an English writer of the twelfth century, and they are now included in a book which was privately printed in 1857, entitled "A Volume of Vocabularies," illustrating the condition and manners of our forefathers from the tenth to the fifteenth century, edited from MSS. in public and private collections, by Thomas Wright, M.A., F.S.A., Hon. M.R.S.L., &c. It was through the zeal and the liberality of Joseph Mayer, F.R.A.S., F.S.A., of Bebington, that these notices were brought to light, and a most useful volume was produced, of which he bore the charge.

As the discovery was made by Mr. Wright, it shall be reported in his own words. In referring to the many points of interest upon which new light is thrown by the vocabularies, he says:—"None of these, perhaps, is of more importance than the curious early allusion to the use of the mariner's compass by the navigators of the western seas. It is well known to all readers that this invaluable invention has been formerly supposed to have been brought from the East, and not to have been known in the West until the fourteenth century, when it was used by the Italian mariners. Allusions to it have, however, been discovered by the students of mediæval literature in works which date as far back as the thirteenth century. In the following pages we find this invention not only alluded to in the twelfth century, but described in such a manner as to show that it was then absolutely in its infancy, and to leave little doubt of its having originated in the West. Alexander Neckam, in his treatise 'De Utensilibus,' enumerates among the ship's stores a needle which was placed on a pivot, and when turned round and left to take its own position in repose, taught the sailors their way when the polar star was concealed from them by clouds or tempest. I have discovered and printed in the note to this passage, a passage in another of Neckam's works, the edited treatise 'De Naturis Rerum,' which gives a more distinct account of this invention. 'Mariners at sea,' he says, 'when through cloudy weather in the day which hides the sun, or through the darkness of the night, they lose the knowledge of the quarter of the world to which they are sailing, touch a needle with the magnet, which will turn round till, on its motion ceasing, its point will be directed towards the north.' A comparison of these two passages seems to show pretty clearly that at this time the navigators had no regular box for the compass, but that they merely carried with them a needle which had been touched with the magnet (perhaps sometimes they carried the magnet also, and touched the needle for the occasion), and that when they had to use it they merely placed it upon some point, or pivot, on which it could turn with tolerable freedom, and then gave it a motion, and waited until it ceased moving. This mode of

¹ See Hochstetter's "New Zealand," English translation, p. 504.
² No. 139, January 1867. The statements of Mr. Judd have called forth several rejoinders in the ensuing number of the *Magazine* for February.

using the needle was, it must be confessed, rude enough. The passage in the treatise 'De Utensilibus' contains one particular which is very obscure, as Neckam informs us that when the needle ceased moving it pointed towards the east (*donec cuspis acus respiciat orientem*); and as all the manuscripts agree in this reading, and it is glossed by *est*, this must be the intention of the writer. I know no way of explaining this, unless it be by the supposition that as in the twelfth century, the East was the grand object of most voyages from this part of the world, an attempt had been made to improve the magnetic needle, by adding to it a limb at right angles, which should point to the east when the needle itself pointed to the north, and that this was what Neckam called the *cuspis acus*. Between this and the date—whatever it may be—of the poem, also quoted in my note on the passage of Neckam, which contains the first allusion to the mariner's compass in the thirteenth century, an attempt had been made to facilitate its use.¹ This was done by thrusting the needle through some substance which would not sink, and placing it upon the surface of water. Guiot de Provins, the author of the poem alluded to, calls this substance a *festu*, a stick or straw (the Latin *festuca*). The mariners, he tells us, have a contrivance depending on the magnet, which cannot fail. The magnet, he adds, is an ugly brownish stone, to which iron is attracted. 'After they have caused a needle to touch it, and placed it in a stick, they put it in the water, without anything more, and the stick keeps it on the surface. Then it turns its point towards the star with such certainty that no man will ever have any doubt of it, nor will it ever for anything go false. When the sea is dark and hazy, that they can neither see star nor moon, they place a light by the needle, and then they have no fear of going wrong; towards the star goes the point, whereby the mariners have the knowledge to keep the right way. It is an art which cannot fail.' According to another poet, the substance through which the needle was usually thrust was cork. He tells us that 'the mariners who went to Friesland, or to Greece, or Acre, or Venice' were guided by the polar star; but when at night, or in obscure weather, it was invisible, they discovered its position by the following contrivance:—'They thrust a needle of iron through a piece of cork, so that it is almost buried in it, and then touch it with the loadstone; then they place it in a vessel full of water, so that no one pushes it out until the water is calm, for in whatever direction the point aims, there without doubt is the polar star.' The MS. in which this latter poem was found is undoubtedly of the fourteenth century; but the poem itself is evidently of somewhat older date of the beginning of that century, or not improbably of the century preceding. It is possible therefore that this rudely constructed mariner's compass may have continued unimproved until the fourteenth century."² (*Introduction*, pp. 16-18.)

¹ In this interval we meet with another slight but very curious allusion to the use of the magnetic needle for the purposes of navigation. Jacques de Vitri, one of the historians of the Crusades, who wrote about the year 1218, says ("Hist. Hieros." cap. 89):—"Acus ferrea, postquam adamante contigerit, ad stellam septentrionalem, que velut axis firmamenti, aliis vergentibus non movetur, semper convertitur; unde valde necessarius est navigantibus in mari."

² This very curious poem, a sort of song, is preserved in a manuscript formerly in the collection of M. Barrois, of Paris, and now in that of Lord Ashburnham. It was first pointed out by M. Fr. Michel, who printed the portion relating to the mariner's compass in the preface to his "Lais Inédits" (Paris, 1836). As this is now a rare book, I have thought it desirable to give here the whole passage, as a complement to the extracts given in the note on p. 114 of the present volume. It is as follows:—

"La tresmontaigne est de tel guise
Qu'ele est si fermement assise
Où ele luist et reflambie :
Li maronier qui vont en Frise,
En Gresse, en Acre, ou en Venisse,
Sevent par li toute la voie ;
Pour nule riens ne se desvoie,
Tout jours se tient en une moie,
Tant est de li grans li service,
Se la mers est enfiee ou koie,
Jà ne sera c'on ne le voie,
Ne pour galeine ne pour bise.

Pour bise, ne pour autre afaire
Ne laist sen dout service à faire
La tresmontaigne clere et pure ;
Les maroniers par son esclaire
Jete souvent hors de contraire,
Et de chemin les assüre.
Et quant la nuis est trop obscure,
S'est ele encor de tel nature,
C'à l'aimant fait le fer traire,
Si que par forche et par droiture,
Et par rulle qui tous jours dure,
Sevent le liu de son repaire,

The following is the text of Neckam with the interlinear gloss:—

ille une pere faut naute
"Qui ergo vult habere navem, albestum habeat, ne desit ei
fu aguil mis
beneficium ignis.¹ Habeat etiam acum² jaculo suppositam,
turne e enurum aguil poynt agardet
rotabitur enim et circumvolvitur acus donec cuspis acus respiciat
est tali modo i. ubi mariners
orientem, sic que comprehendunt quo tendere debeant naute cum
cinossura" [the cynosure, *kurótroupa*, or constellation popularly
called Charles's wain] [atapist de l'eyr tempeste cinossura
acheement circle petit
occamus nunquam tendat propter circuli brevitatem." ("De
Utensilibus," p. 114.)

Mr. Wright adds: "The earliest account of the mariner's compass, before known, was contained in the following lines of a satirical poem, entitled the 'Bible Guiot de Provins,' composed in the thirteenth century." (Barbazan, "Fabloix," tom. ii. p. 328.)

"Un art font qui mentir ne puet
Par la vertu de la maniete,
Une pierre laide et brustee,
Où li fers volontiers se joint,
Ont: si esgardet li droit point,
Puis c'une aguille i ont touchie,
Et en un festu l'ont couché,
En l'ev'e le metent sanz plus.
Et li festuz la tient desus ;
Puis se torne la pointe toute
Contre l'estoile, si sanz doute,
Que jà nus hom n'en dontera,
Ne jà por rien ne fausera.
Quant la mers est obscure et brune,
C'on ne voit estoile ne lune,
Dont font à l'aguille alumer,
Puis n'ont li garde d'esgarer ;
Contre l'estoile va la pointe,
Por ce sont li mariner cointe
De la droite voie tenir.
C'est uns ars qui ne puet failier."

The language of the last extract fully bears out Mr. Wright's estimate of it as not earlier than the thirteenth century.

WM. CHAPPELL

The Dry River-beds of the Riviera

MR. H. T. WHARTON'S letter (*NATURE*, vol. xiii., p. 448) does not seem fully to explain the difficulty expressed by Mr. R. E. Bartlett (*NATURE*, vol. xiii., p. 406), a difficulty which is often felt by many of the visitors to the Riviera. Mr. Wharton is quite correct with regard to the Paglione. This stream has, I believe, within the last few years been often in high flood, and has been more than once within a foot or two of the top of the arches of the bridge which Mr. Bartlett seems to think is unnecessarily large. The Paglione, where it passes through Nice, is not, however, a fair representative of the river-beds of the Riviera. When the river-walls were built, which now retain the Paglione, the river-bed was, in all probability, made much narrower than it previously was, on account of the value of the land for building purposes, and only so much of the river-bed retained as was necessary to carry away the water, so that the Paglione now completely fills its channel when in flood. This is far from

Son repaire se vent à route,
Quant li tans n'a de clarté goute,
Tout chil qui font cest maistrise,
Qui une aguille de fer boutte
Si qu'ele pert presque toute
En .i. poi de liege, et l'atise
A la pierre d'aimant bise ;
En .i. vaissel plain d'yave est mise,
Si que nus hors ne la deboute,
Si tost com l'yave s'aserise ;
Car dous que li part la pointe vise,
La tresmontaigne est là sans doute."

¹ It was believed that the asbestos, when once lighted, could never be extinguished, and hence Neckam recommends it to be carried on shipboard, that the sailors may never be without fire.

² This rather obscure description of the mariner's compass, belonging certainly to the twelfth century, is the earliest allusion to the use of that important instrument in the middle ages. Alexander Neckam has, however, given a rather fuller description of it in another of his books, the treatise "De Naturis Rerum," lib. 2, c. 89 (MS. Reg. 12 G. xi., fol. 53 v°):—"Nautae etiam mare legentes, cum beneficium claritatis solis in tempore nubilo non sentiunt, aut etiam cum caligine nocturnarum tenebrarum mundus obvelitur, et ignorant in quem mundi cardinem prora tendat, acum super magnetem ponunt, que circulariter circumvolvitur usque dum, ejus motu cessante, cuspis ipsis septentrionalem respiciat." (Here the error about pointing to the east is corrected.)

being the case with most of the Riviera torrents. For instance, the channels of the streams near Menton, Vintimiglia, and elsewhere, are far out of all proportion to the work they have to do. Take the case of the principal stream at Menton. At a distance of less than two miles from the sea where its bed is formed of rock, it has only a breadth of a few yards, and has no high flood-marks indicating that there is ever a great depth of water. If the stream is followed downwards from this point for less than a mile, the bed is found to open out to a breadth of from sixty to seventy yards. Between these points there are no tributary streams adding their waters to account for this increase. These large river-beds are caused by the nature of the country which these rivers drain. The country is very mountainous, the hill slopes are rocky and steep, large areas have no covering of soil, and what soil there is does not retain the water well. The result of this is, that when rain falls the water rapidly finds its way to the streams, and the same amount of rainfall is discharged by these streams in a few hours as is discharged in weeks by an English river draining the same area. This accounts for these torrents rising so "high" and falling so "low." It also accounts for them "rising" and "falling" rapidly.

But further, the great and unnecessary breadth of these torrent-beds where they approach the sea seems to be produced somewhat in the following way:—The valleys through which these streams flow descend rapidly from the mountains, but as they approach the sea their slope becomes much slower; the result of this is, that the gravel brought down by the river from its higher and more rapid reaches, is here deposited, on account of the water losing its velocity, and the bottom of the valley becomes filled with a bed of gravel, through which the stream winds sometimes in one part, sometimes in another. A very small cause being sufficient to make the stream "cut" into the gravel and alter the position of its bed, and cause it to flow in different parts of the channel at different times, but it almost never covers at one time the whole breadth of it.

That the bed of the principal stream at Menton is unnecessarily large, is evident from the fact that now, on account of the increased value of land, they are building a retaining-wall near the centre of the stream, and filling up about one-half of the river-bed for the purpose of cultivation.

Rivers similar to those of the Riviera are common to all mountainous countries, Britain not excepted. There is at least one salmon river in Scotland, which during the dry season may be walked across without wetting the soles of one's boots, all the water finding a passage among the gravel. Yet in Autumn, when it has fallen to "fishing condition," it is a stream of about thirty yards broad, and an average depth of about two feet on the fords. This river is also subject to great floods, which "come down" rapidly, and "fall" rapidly. It also has gravel deposits similar to those of the Riviera torrents, but in this case they are covered with soil and cultivated, and it is with the greatest difficulty and at great expense that the river is prevented from widening its channel to the proportions of those of the Riviera torrents.

JOHN AITKEN

Bellagio, Lago di Como, Italy

Method of Distributing Astronomical Predictions

I BEG leave to observe that the very useful method of distributing astronomical predictions over a given geographical area alluded to in NATURE, vol. xiii., page 71, and ascribed there to Mr. W. S. B. Woolhouse, was already proposed by my father, J. J. von Littrow, in his treatise, "Darstellung der Sonnenfinsterniss vom 7 September, 1820," Pest, 1820, as well as in the *Berliner Astronomisches Jahrbuch*, for 1821, page 116, and 1822, page 145; subsequently in his "Theoretische und praktische Astronomie," Wien, 1821, part ii., page 280; and last in his "Vorlesungen über Astronomie," Wien, 1830, part I., page 306. Since then numerous applications have been made thereof. My father expressed the well-founded desire that in the astronomical almanacs formulae might be given similar to that communicated in NATURE.

CHARLES DE LITTROW

Vienna, June 1

Acoustical Phenomena

IN connection with Doppler's disputed theory of the colours of stars, the illustration usually employed to assist the mind in forming a conception of the hypothesis is that of the whistle of a passing locomotive. The note of the whistle, which, as it

approaches, seems shriller than its normal pitch, owing to the greater number of vibrations impinging upon the ear in the unit of time, falls half a tone more or less, as the engine passes and recedes. To unmusical ears the difference in the note is a very doubtful fact, only to be taken on hearsay. There is, however, another fact of kindred nature to which attention has not, I believe, been generally drawn. Almost all railway engines, and especially those drawing heavy goods' trains, have, owing to the manner in which the valve-gearing is set, the property of producing the well-known *staccato* puffs of steam, audible to the ear as well as evident to the eye. Anyone who will listen to these puffs as the train dashes by will be aware of a very distinct and well-marked change in their apparent rapidity of succession at the moment of passing. So distinct is the change that almost invariably the first effect on the mind is the illusory suggestion that the train has suddenly slackened speed. This change is heard best at night, and when the passing train is a heavy one, not running too quickly. It cannot fail to be appreciated even by non-musical ears. As an illustration of a scientific principle it is, perhaps of the greater value, as a popular error seems to exist on the subject of the change of the note of the whistle, to the effect that the lowering in pitch is very gradual during the approach and recession of the engine, an opinion obviously incorrect if the observer be close to the train.

London, June 7

S. P. THOMPSON

Giant Tortoises

IN NATURE, vol. xiv. p. 60, it is stated that Commander Cookson, of H.M.S. *Petrel*, is bringing home two live specimens of the giant tortoise of the Galapagos; that *if* their food lasts, and *if* they are not killed by the cold off Cape Horn, they will be the first specimens seen alive in this country.

Even should the tortoises survive the two *ifs* above given, they will not be the first living specimens seen in this country.

A large specimen brought from the Galapagos Islands by one of the ships of the late S. R. Graves, M.P., lived in good health for nearly ten years in our Dublin Zoological Gardens.

This animal was examined, after death, by Dr. Günther, who states that it is not identical with the Indian species, as supposed by former naturalists.

SAMUEL HAUGHTON,
Secretary Royal Zoological Gardens,
Dublin

Trinity College, Dublin, June 2

Photography of the Loan Collection Apparatus

THE Loan Collection of Scientific Apparatus at South Kensington contains many apparatus, as for instance the first air-pump of Otto von Guericke, the first boiler of Papin, the first locomotive, &c., which for the friends of science will ever be of great historical interest. Therefore I cannot refrain from expressing the wish that opportunity should be given to take photographs of convenient size of some of the most interesting apparatus. I believe many visitors will feel with me greatly gratified if such a more enduring remembrance could be taken home of an exhibition that perhaps for ever will remain unequalled.

The Hague, June 12

L. B.

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE

THE courteous request of the editor of NATURE that I should contribute to his pages an abstract of my experience of the value of experimentation on animals and on the most useful applications of that method of research to the alleviation, directly or indirectly, of animal suffering in all the higher classes of animals is responded to in the subjoined notes.

I have already expressed my views on this subject on two occasions at large public meetings of the Royal Society for the Prevention of Cruelty to Animals, and in 1862 I made a report on the same subject to the indefatigable secretary of that society, Mr. Colam, which report he has recently published, and which on the points it refers to is in harmony with the conclusions of the late Royal Commission. I have not, however, entered into the discussion that for some months past has been in

progress, and this for the simple reason that in the violence, I had almost said distemper, of the controversy, I felt I could take no part. In what I am now about to record I shall merely bear witness of what I know without prejudice to either side. I state this at once because I feel morally sure that if I had not been a physician, and if I had not from that circumstance studied the question in connection with human suffering in its most poignant aspects, I should have been one of the strongest partisans amongst those who are most strongly opposed to experimentation. I differ indeed only from them in that I have been obliged to consider the pains of men, women, and children in my daily labours, and have been forced to the conviction that the actual suffering of the inferior animals bears no comparison with that which is borne by the human family; that the mental sufferings alone of man exceed the physical pains of the lower creatures; and that his physical pain is greater in amount, in intensity, and in appreciation.

For my part, the experience I have gained from experimentation has, from the beginning to the end, through a long period of twenty-six years—during which it has at intervals been sought—sprung in almost every instance, directly from the desire to apply scientific research to the instant use of the practising physician. With rare exceptions every inquiry has been prompted by some painful difficulty that has been suggested at the bedside of the sick, or by the sight of operation on the human subject.

If, therefore, experiment on animals can be vindicated by its application to practice, my experience may be of use in settling doubts in the minds, at least, of those who are not unduly biassed on either side.

Experimentation on Death from Chloroform

The first series of experiments I remember to have made were commenced in the years 1850 and 51, and had reference to the mode and cause of death under chloroform. At the time named chloroform had been in use a little over two years, for preventing the pain of surgical operations, and already nineteen deaths in man had occurred from it.

These calamities had produced very painful and anxious feelings amongst medical men, and my researches had for their intention the elucidation of many points of practical importance. The mode of procedure was to narcotise the animals with varying degrees of rapidity, with varying percentages of chloroform vapour in the atmosphere, and during various atmospherical conditions: to notice carefully the phenomena produced on the heart and on the respiration, and the duration of the four stages of narcotism. In some instances the animals—rabbits were usually subjected to experiment—were allowed to recover; in other instances the narcotism was continued to death. When the narcotism was made to be fatal the immediate cause of death was noted, and the body was left until the rigidity of death could be recorded. Then all the organs were carefully inspected in order to see what was the condition of the lungs, the heart, the brain, the spinal cord.

The results obtained by these inquiries were of direct practical value. By them I showed in various lectures and papers the following major facts:—

1. That the cause of the fatality from chloroform does not occur, as was at first supposed, from any particular mode of administration of the narcotic.
2. That chloroform will kill, in some instances, when the subject killed by it exhibits, previous to administration, no trace of disease or other sign by which the danger of death can be foretold.
3. That the condition of the air at the time of administration materially influences the action of the narcotic vapour. That the danger of administration is much less when the air is free of water vapour and the temperature is above 60° but below 70° Fahr.
4. That there are four distinct modes of death from

chloroform, and that when the phenomena of death from its application appear, they are infinitely more likely to pass into irrevocable death than from some other narcotics that may be used in lieu of chloroform.

5. That all the members of the group of narcotic vapours of the chlorine series, of which chloroform is the most prominent as a narcotic, are dangerous narcotics, and that chloroform ought to be replaced by some other agent equally practical in use, and less fatal.

6. That so long as it continues to be used there will always be a certain distinct mortality arising from chloroform, and that no human skill in applying it can divest it of its dangers.

That knowledge of this kind respecting an agent which destroys one person out of every two thousand five hundred who inhale it was calculated to be useful no reasonable mind, I think, can doubt. To me who, many hundred times in my life have had the solemn responsibility of administering chloroform to my fellow-men, it was of so much value that I should have felt it a crime if I had gone blindly on using so potent an instrument without obtaining such knowledge.

Experimentation with reference to the Deposition of Fibrine in the Heart, and Prevention of Death from that Cause.

From 1851 to 1854 I was closely occupied in the study of that mode of death which is caused by the separation of the fibrine of the blood in the cavities of the heart. At the time named a medical controversy which had been all but silent for a hundred and fifty years, on the question whether the separations of fibrine which are often found in the heart after death are formed before death and are a cause of death, or are formed after death and are a mere consequence, was revived and was carried on, with much activity, by physicians of different schools. I took a leading part in supporting the view that the separations of fibrine took place, as a rule, before death, and were the cause of death. I did a great deal to prove the truth of this then controverted, and now universally admitted, position, and I gave the first detailed description of the symptoms which indicate the formation of the clots in the cavities of the heart. The result was that I soon became too sadly familiar with this class of case, for I found that the symptoms, whenever they were fairly pronounced, indicated the certain death of the sufferer. These observations led me, naturally, to look for a remedy; to an endeavour to find a means by which the clot of fibrine in the heart could be made to undergo solution. Taking clots that had been removed from the dead and had been causes of death, I subjected them to different solutions to determine their solubility. I found them soluble in some alkaline solutions, and amongst other solutions in ammonia. I also observed that ammonia added to blood held the fibrine of the blood, from which these clots are formed, in solution. The fact led me to expect that by the use of such alkaline solutions a true solvent remedy might be found. A case occurred in which symptoms of fatal character were fully developed, and in the hope of producing solution of the coagulum in the heart, full doses of bicarbonate of ammonia were repeatedly administered. To my great satisfaction the signs of oppression at the heart ceased, life was evidently prolonged, and a fair chance of recovery was presented. The hope of recovery was in a few hours, however, destroyed; coma supervened, and the patient died from that added cause of death. The *post-mortem* revealed that the blood throughout the body was fluid, and that the clot which had been in the heart had undergone all but complete solution. But the red corpuscles of the blood were found also to have undergone the extremest disintegration, and the brain and other vital organs were intensely congested.

The inference I drew at this time, it was in 1854, from

the example in question, was that the remedy which had caused solution of the coagulum had saved life by that process to destroy life by the extension of the solvent action to the blood corpuscles, and this opinion was so fully confirmed by experimentation, that I gave up further inquiry on the subject, from the feeling that its continuance was not warranted. A period of seventeen years now elapsed, in every year of which I had occasion to see from five to six instances of death from this one cause. Some of the deaths from the cause named occurred after surgical operations, such as ovariectomy, some from croup and other inflammatory affections, others before or after childbirth. In 1870 I computed that I had witnessed ninety-seven of these fatal catastrophes. Meantime there had been found no remedy, but I had learned from the added experience one new fact, viz., that in three instances, although no ammonia or other solvent of the blood had been employed in treatment, the symptoms of coma supervened precisely as in the case where ammonia had been administered. At last I obtained one clear evidence that the reason of the symptoms was a separation of fibrine in the sinuses of the brain.

Recurring once more to the use of ammonia as a solvent of the deposited fibrine, I thought it justifiable now to renew experiment. It might, I felt, be the best course to administer the simple liquid ammonia instead of a salt of that substance, by which means I hoped the solvent action would be obtained by an agent that was more easily eliminated from the body when the administration of it was withdrawn.

To what extent I might administer the solvent, how far I might venture to produce disintegration of the corpuscles of the blood and hope for recovery, was the point to be arrived at. It could only be arrived at by one of two methods—by trying the experiment on the inferior animals, or by waiting for the opportunity of testing the remedy directly on man in some extreme case of the diseased condition specified. I chose, and I think correctly, the first of these alternatives. I subjected an animal, a guinea pig, to the administration of ammonia diluted as it might be for the human subject, and I continued the administration until I found, firstly, that life was possible and safe under a degree of solution of blood which in the absence of such a direct test would have been thought impossible; and secondly, that on the withdrawal of the solvent agent the natural state was slowly but completely restored. I repeated the research in order to test the best mode of administration. I tried on myself the doses that could be swallowed without actual pain, and then I planned the measure I would adopt when another instance of obstruction of the blood in the heart came under my care. I need not repeat here, in any detail, the satisfactory results of this inquiry. The facts have been recorded at length before the Medical Society of London, have been made widely known in the profession of medicine, and have gathered confirmation from others. It is sufficient for me to state that in 1872, in an example of this fibrinous obstruction in the heart, when the sufferer was to all known observation *in extremis*, the treatment by ammonia, in doses which would have been considered poisonous had not experiment on animals proved the contrary, was pushed to the full; that the evidence of solution of the obstructing mass in the heart was perfect; and that complete recovery, I have no doubt the first recovery of the kind, was the result. Since then I know of eight more examples in which the same rational method of treatment has been applied, with the result of six recoveries.

Experimentation for Surgical Learning.—Ovariectomy.

I have sometimes had occasion to perform, or take part in experiments on the lower animals in order to learn some important detail of surgical practice. The following experience of this nature is worthy of special note.

When Mr. Spencer Wells was beginning his career in performing the operation of this century,—the removal of ovarian tumours,—a difficulty arose on the point whether in closing up the wound in the abdomen the peritoneum ought or ought not to be included in the stitches. At the present time, when so much is known, this subject may appear of little moment; then it was of vital moment. The peritoneum had been held by all authorities to be of such importance in the animal economy that to cut or injure it was thought to be actually a deadly act, and a man who intentionally injured the peritoneum, in operation, was considered, by many, as little better than a wanton and wicked experimenter on human life. Ought any one, therefore, to venture to put two rows of stitches through this structure? Mr. Wells wished to ask the question of nature, by experiment, and I helped him. Eighteen animals of three classes—guinea-pigs, rabbits, and dogs—were first thoroughly narcotised. Then the same incision was made into the abdominal cavity as is made in ovariectomy. Afterwards the incision was neatly and closely sewn up, in one set of experiments with the peritoneum included in the stitches, in the other set with the peritoneum excluded. The animals, on coming out of their sleep, were attended to and treated with as much care as if they had been human until their recovery, which in each case was rapid and easy. When they had entirely recovered and the wound healed, they were submitted to painless death, under anaesthesia, and their bodies were examined to determine the results of the different modes of operation.

These were the steps of the proceeding. The lessons taught were of vital value. The experimentation proved beyond dispute that the introduction of the stitches through the peritoneum added no danger to the operation. They proved further that when the peritoneum was included in the stitches, the wound healed much more firmly and safely, a fact which could only have been learned from an operation on a subject that could be killed after operation. From that time of probationary learning on to this time of matured experience, Mr. Wells has performed the great operation, with which his name is for ever identified, 770 times. In every instance the patients who have come under his care for operation would, presumably from past experience, have died from the disease. Of his patients operated on an average of three out of four have recovered. He has, therefore, by his own hand saved between five or six hundred women from one form of certain and lingering death. Towards this result—a result grander than has ever before fallen to the lot of any operator of any age—he was fortified by the experiments I have described to an extent which no one but an operator himself can fully appreciate.

I am aware there are some who would urge that he might have learned the facts he wanted to obtain by experience, that is to say he might have waited for the results from his operations on women. This plan would have made several women in the prime of life subjects of experimental inquiry. I am aware that some would say it were better the operation had been dropped than that any animal whatever had been subjected to suffering for its sake. This plan would have been an obstacle to the saving of over five hundred women from early and certain death in the practice of Mr. Wells alone. But when it is remembered that his teaching and example have been followed wherever surgery is practised, the numbers of women saved from death and suffering during the last fifteen years in consequence of what was learnt by sacrificing some eighteen dogs, rabbits, and guinea-pigs, it is obvious that those who estimate human life at its real value and observe human suffering in its most distressing forms are compelled, however painful to their own feelings, to think and act first for the best interests of the human family.

What Lord Selborne, one of our most distinguished

Chancellors, thinks of the results of Mr. Wells's work may be gathered from one of his published speeches. He calls it "one of the most splendid triumphs of modern surgical art and modern philanthropy, one of the greatest achievements of medicine or surgery in any age." Mr. Wells himself has repeatedly urged that what he learnt by the result of the experiments we performed together has been of the utmost importance for the success of the operation, and in a note addressed to me to-day he repeats and permits me to publish his views in his own words:—

"The few experiments we made on the narcotised animals taught in a few weeks, in the early days of ovariotomy, what I could not have learned to this hour, after many years' observations on suffering women. To my mind, the loss to the world by the few animals sacrificed, when compared with the gain by the lives of the thousands of suffering women already saved, wherever the improved methods of operating learned by these experiments has been followed, is so utterly disproportionate as not even to be worthy of consideration."

BENJAMIN W. RICHARDSON

(To be continued)

OUR ASTRONOMICAL COLUMN

THE COMET OF 1698.—The orbit of the comet of 1698, which appears in our catalogues was calculated by Halley from the observations of Lahire and Cassini at Paris. In his "Synopsis of the Astronomy of Comets" he remarks that the comet "was seen only by the Parisian observers who determined its course in a very uncommon manner. This comet was a very obscure one, and although it moved swiftly, and came near enough to our earth, yet we, who are not wont to be incurious in these matters, saw nothing of it."

The comet was detected on Sept. 2, between β and κ Cassiopeæ, and thence pursued a southerly course until on the 28th of the same month it was last observed between ξ and ψ Scorpii. On calculating geocentric places from Halley's orbit, it appears that the elements as originally published by him, and as they have been successively copied into all our catalogues, give an apparent track in the heavens which is totally different from that recorded by Lahire and Cassini, and described in *Anciens Mémoires de l'Académie des Sciences*, t. x., and which is traced on the chart in the *Mémoires* for 1702. Employing positions deduced as closely as practicable from the somewhat imperfect details in our possession, for Sept. 2, 15, and 28, the following orbit results:—

Perihelion Passage 1698, Sept. 17	0214 Paris mean time.
Longitude of the perihelion ...	274° 42' } Equinox
" Ascending node ...	65 53 } of 1699.
Inclination ...	10 55
Log. Perihelion Distance ...	9.86252
Heliocentric motion — retrograde.	

On comparing these elements (which very fairly represent the apparent track of the comet) with Halley's, it is at once evident that the cause of the failure of the latter is the substitution in the "Synopsis" of the longitude of the *descending*, instead of that of the *ascending* node, an oversight which appears to have escaped detection hitherto. Making this change in Halley's elements they will stand as follows:—

Perihelion Passage 1698 Oct. 18	at 16h. 57m. Greenwich
Longitude of Perihelion ...	270° 51' 15" time.
" Ascending Node ...	87 44 15
Inclination ...	11 46 0
Log. perihelion distance ...	9.83966
Motion — retrograde.	

The first orbit appears to agree better upon the whole with the path of the comet laid down in the above mentioned diagram.

THE BINARY STAR ω LEONIS.—In the "Transactions of the Royal Irish Academy," vol. 26, Dr. Doberck has given the details of a very elaborate determination of the orbit of this star, on measures extending to the spring of the present year. Mädler had previously given two orbits, Villarceau one, and Klinkerfues three, so that the object had not been neglected, but a longer course of measures than had been employed by these calculators was required for a trustworthy approximation to the orbit. Dr. Doberck presents the following elements as definitive for the present:—

Peri-astron passage ...	1841.81
Node ...	148° 46'
Angle between the lines of nodes and apses (λ) ...	121° 4'
Inclination ...	64° 5'
Excentricity ...	0.5360
Semi-axis Major ...	0".890
Period of revolution ...	110.82 years.

From these elements we deduce the following angles and distances, exhibiting the course of the companion during the present century:—

1878.0	Pos. 75.1	Dist. 0.56	1890.0	Pos. 102.4	Dist. 0.75
82.0	" 86.0	" 0.62	94.0	" 108.5	" 0.82
86.0	" 95.0	" 0.68	98.0	" 113.6	" 0.89

Some remarks on the correction of orbits of double stars, appended by Dr. Doberck to his paper on ω Leonis, one of the most complete of the series emanating from Col. Cooper's Observatory at Markree Castle, may be useful to those who are occupied with these orbits.

VARIABLE STARS.—(1) Olbers' supposed variable, near 53 Virginis. Mr. J. E. Gore, writing from Umballa, Punjab, on May 13, says he examined the place of this star a few nights previous with a 3-inch refractor, and found it about 9 m., being about equal in brightness to Olbers' star c , and brighter than his star d , which latter appeared more nearly $9\frac{1}{2}$ or 10 than 11, as given by Olbers. With an opera-glass the suspected variable was "about the faintest star in the immediate vicinity of 53 Virginis."

(2) 5 Ceti.—Recent observations afford a suspicion of variability to a small extent in this decidedly reddish star, which, by the way, is not found in Schjellerup's second catalogue of objects of this class. It may be advantageously compared with its neighbours 4 Ceti and B.A.C. 5. (3) The Companion of Algol. The small star near β Persei, appears to have been first remarked by Schröter, on October 12, 1787, with a 7-feet telescope, power 160; on November 3 the distance was estimated 1' 30". On April 9, 1788, he could not find the small star, and hence concluded it to be variable. Observations during the last two or three years have rather indicated fluctuation of brightness, the star being sometimes caught at once, and at others only perceived with difficulty, employing the same telescopes and on nights not differing materially in transparency. It would not be without interest to ascertain definitely by systematic observation whether there is any ground for the suspicion first entertained by Schröter.

THE DOUBLE-STAR γ CENTAURI.—Will one of our southern readers put upon record the actual angle of position and distance of this object, to decide upon the direction and amount of the motion, which at present are by no means obvious? Capt. Jacobs' measures in December, 1857, showed that the star was widening, as compared with his estimate in March of the preceding year, but he found a retrograde change of angle to the amount of 7°, whereas the angle of 1856, compared with Sir John Herschel's measures in 1835-36, rather point to direct motion. Capt. Jacobs says, in 1857, "Has opened sensibly since 1853, being now an easy object, whereas then, under the most favourable circumstances, it could only just be discerned as not round."

THE MAMMALS AND BIRDS OF BURMA¹

DURING the last few years of his life, the late Mr. Edward Blyth—whose death on December 27th 1874 we referred to on the following week—devoted much of his time to the production of a Catalogue of the Mammals and Birds of Burma. This he had originally commenced as a sketch of the Natural History of Burma, to form a chapter in a work on that country by Sir A. Phayre; but as he had gone too exhaustively into the subject for that purpose, Sir Arthur, on receiving the manuscript after its author's death, handed it over to Mr. Arthur Grote, with the view of its being published in the "Journal of the Asiatic Society of Bengal." To this the Council of the Society willingly assented, the result being that Blyth's posthumous "Catalogue of the Mammals and Birds of Burma" has appeared as an extra number of that journal, with an interesting and detailed biography by Mr. Grote. Different authors, with notes and additions, edit the different sections. Dr. John Anderson, the present curator of the Indian Museum of Calcutta, has undertaken the Mammals, with the exception of the Bats, which have been placed under the charge of Dr. G. E. Dobson; whilst Lord Walden edits the Birds. The editorial notes are all inclosed within brackets, so that there is no difficulty in distinguishing the author's own views. Without the notes and additions the work would not have been a complete one; as it now appears, it is an exhaustive account of the mammali- and avi-fauna of the Burmese portion of our Indian Empire.

Mr. Blyth's peculiar power of perceiving specific differences, together with his general scientific acumen, had full opportunity of displaying themselves when he in 1841 undertook the charge of the mass of unassorted material, in the forms of skins and bones, accumulated at Calcutta by the labours of Messrs. Hodgson, Cantor, and others. His thorough study of these enabled him to employ to the greatest advantage the opportunities which occurred to him of visiting Burma, which he did on several occasions, between 1860 and 1862. The results of these are embodied in the work under consideration, which as a simple catalogue would have been valuable, but is made doubly so by the extremely instructive comments which accompany many of the descriptions, and indicate how acute were the powers of their author as a naturalist. This may be further proved by the fact that of the 129 species of mammals known to inhabit Burma, thirty are recognised by names given by him.

As a point to which we would take exception we must refer to the name by which the author designates the "Ear-fringed Rhinoceros," first described by Mr. Sclater, from a unique specimen now living in the Zoological Gardens in the Regent's Park, as *Rhinoceros lasiotis*. It happened that Dr. Gray had given the name *R. crossii* to the owner of a rhinoceros horn, 17 inches in length, the shape of which was different from that of any known species. Why, when a new species is discovered, the horn should be assumed to be one of those belonging to it, is far from easy to understand, and Mr. Blyth gives no reasons for his nomenclature. He does place a note of interrogation after the name. If we remember correctly, the stuffed specimens of *R. sumatrensis* in the British Museum bear the name of *Ceratotherium crossii*.

METEOROLOGY AT MELBOURNE²

THESE first three volumes of the new issue of the results of the meteorological observations carried on in Victoria under Mr. Ellery's direction, give copious

¹ "Catalogue of Mammals and Birds of Burma." By the late E. Blyth, C.M.Z.S. "Journal of the Asiatic Society of Bengal," new series, vol. xliii Part 2.

² Results of Observations in Meteorology, Terrestrial Magnetism, &c., taken at the Melbourne Observatory during the years 1872, '73, '74, with Abstracts from Meteorological Observations obtained at various Localities in Victoria, under the superintendence of Robert L. J. Ellery, Government Astronomer.

details of all the work done at Melbourne, the chief observatory of the colony, the means and extremes of barometer and thermometer at from six to ten stations, and the amount and days of the rainfall at from twenty-six to thirty-four stations, the latter being the number of rainfall stations in 1874. To these are added, copious and very valuable *résumés* from all the thirty-four stations, of electrical phenomena, hail, frost, snow and sleet, fog, hot winds, storms of wind, auroras and earthquakes, most of which form so important elements in the climatology of Victoria.

The daily results for pressure, temperature, and evaporation, which are printed for Melbourne from observations made at 6 and 9 A.M., and 3 and 9 P.M., have been "corrected" so as to render their values, and those derived from them, equivalent to those deduced from hourly observations, presumably from the hourly values determined by Dr. G. Neumayer. This method of publishing results is objectionable particularly as regards daily observations; and even as regards monthly means, it is not free from serious objection, because, owing to the varying limits of the daily oscillations, this method of correcting observations must frequently mislead.

The anemometrical results for Melbourne are extremely valuable. In the summer months southerly winds and in the winter months northerly winds largely preponderate. Thus in 1874—while in January northerly winds (N.E., N., N.W.) showed a percentage of 11.3, southerly winds (S.E., S., S.W.) showed a percentage of 74.0; in July, on the other hand, the numbers were, northerly, 58.9, and southerly, 23.2. Again, in July, the three hours of the day showing the least velocity of the wind are 4 to 7 A.M., the mean being 7.2 miles per hour, and the three hours of greatest velocity noon to 3 P.M., the mean being 11.8 miles. But in January the three hours of least velocity are 3 to 6 A.M., the mean being 6.3 miles, and the three hours of greatest velocity 2 to 5 P.M., the mean being 15.8 miles. Hence in summer, even though storms of wind are then least frequent, the maximum daily velocity of the wind which occurs two hours later, is 4 miles greater an hour, being the direct result of the powerful action of the sun on the heated plains of the interior of Australia. It is to be hoped that in future issues Mr. Ellery will be able to add to these invaluable tables, a table showing the mean hourly variation in the direction of the wind for each month, a climatological datum of the first importance in Meteorology to which we have recently drawn attention in reviewing the reports of Toronto and Habana.

To each month's results are added the barometric, thermometric, hygrometric, and rain averages for eight of the stations, and since nearly all these averages are for periods varying from eleven to sixteen years, some interesting conclusions of a general character may now be drawn applicable to the whole colony. Thus in January the average pressure at 32° and sea-level is 29.962 inches at Cape Otway, on the coast, and 29.893 inches at Sandhurst, in the interior; but in July the averages are respectively 30.042 and 30.110 inches. These results show a diminution of pressure during summer in advancing inland, and an increase in winter, a distribution of atmospheric pressure in accordance with the prevailing winds in these seasons. In January the mean temperature varies from 60°·6 at Cape Otway to 70°·8 at Sandhurst; and at Beechworth, which is still more decidedly inland, the mean temperature is 2°·0 above that of Sandhurst, though it be fully 1,000 feet higher. At Cape Otway the difference between the coldest and warmest months is 13°·4, whereas at Sandhurst it is 25°·1.

The mean annual temperatures of Cape Otway 54°·7, and Portland 61°·5, call for examination. Cape Otway and Portland, which are nearly in the same latitude, both on the coast and only about fifty miles apart, show thus a difference in their mean temperatures of 6°·8, or a differ-

ence equal to that between Greenwich and Montpellier in the south of France—a difference which might possibly arise from extraordinary and diverse ocean-currents—but to such a supposition current charts give no support. The publication might be rendered even still more useful by including among the means those of the maxima and minima of temperature, and those at the hours of 9 A.M. and 3 P.M. for pressure and temperature at all the stations, and by indicating on the map the whole of the stations from which observations are given in each year's publication.

AMERICAN-INDIAN STONE TUBES AND TOBACCO-PIPES

DURING the summer of 1873, I found a single specimen of a stone tube, that had been split throughout its entire length, as seen in Fig. 1. Since then, I have had an opportunity of examining several specimens found in New Jersey, and fortunately found two in the locality of my principal labours, in gathering up the scattered relics of the aborigines.

Fig. 1 is made of beautiful veined green and black slate, is six and one-eighth inches in length, slightly oval, and has been highly polished. The bore, which is exactly half-an-inch in diameter, is circular, uniform and direct. The drilling has evidently been accomplished by the use of a reed with sand and water, and the circular striae are visible throughout the length of the perforation. This drilling is the more interesting from the fact, that the work, commenced at one end, has been continued to the other, and not from either end to the middle, which latter method (and much the more common one) produces an hour-glass contraction at the point of juncture of the two drillings. Six or seven inches, however, was not the maximum depth attempted at drilling in one direction. Prof. Wyman, in "Fifth Report of the Peabody Museum of Archaeology,"

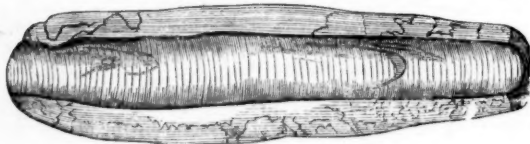


FIG. 1.—One-half natural size.

p. 13, describes "a cylindrical tube of soap-stone, twenty-two inches long and two inches in diameter, tapering somewhat at either end. This had been drilled from opposite ends, but the two perforations not coinciding, they passed by each other, the bores communicating laterally." We have in this implement, therefore, a single bore at least twelve inches long; which is probably the maximum length, for it is difficult to conceive of a stone to be of greater length than two feet, being of any use.¹ This is about the maximum of the non-perforated cylindrical stones called pestles; but which probably had other uses than that name implies.

Fig. 2, represents a quite common form of ornamental stone implement, but which, unfortunately, are seldom found except in very fragmentary condition. This specimen measures six and seven-eighths inches in length, by eight inches, lacking three-sixteenths, in breadth. The mineral is a soft sandstone, smoothed but not polished, and free from all attempt at ornamentation. Such specimens, when of less dimensions, have ordinarily been classed as badges of authority, gorgets, or if narrower, as double-edged axes, which could never have been their use, considering the soft material of which they are invariably

¹ Mr. Evans, in his "Ancient Stone Implements of Great Britain," remarks that "the tubes of steatite one foot in length found in some of the minor mounds of the Ohio Valley, must probably have been bored with metal." This depends altogether upon their age. New Jersey specimens of tubes have been found of nearly that length, which undoubtedly were made before the introduction of metal.

made. As the perforation of this specimen exceeds in length that of the preceding, I am led to consider this simply as a "winged" tube, and to have had a use identical with such as above described (Fig. 1). While cylindrical tubes, plain or ornamented, are quite abundant in

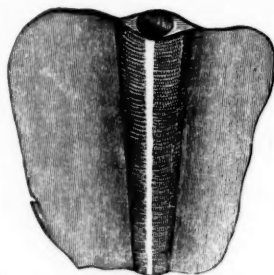


FIG. 2.—One-fifth natural size.

the southern and western states, these winged tubes appear to replace them in the northern and middle states.

Figs. 3 and 4 represent two specimens of tubes, that are of much interest, in that, while of the same general character as the preceding, they have not been bored; but are made of clay which has been moulded when soft, about a straight cylinder, presumably of wood, and then baked very hard. The exposure to fire would necessarily char, if not consume, the encased wood, and so leave a perforation in the clay when baked. This tube has then been brought to its present shape by scraping, and the ornamentation lastly carved upon it. In both specimens, the projective figure has been broken off, but the remaining fragment in Fig. 3 suggests the figure of a mammal, and that of Fig. 4 possibly a human head. On the tube, Fig. 3, will be noticed five short parallel lines. Such rows



FIG. 3.—One-third natural size.

of short deeply engraved lines are very characteristic of the relics found in New Jersey (see figure of Marriage Emblem in NATURE, vol. xi., p. 436), and are probably record marks, but of what, on an implement like this, it is difficult to conjecture. The general shape of these tubes, and their diameters render it quite certain that they are not simply the stems of clay smoking-pipes.

These two specimens were found in the same grave, associated with the ordinary weapons of the aborigines; axes, spears, and arrow-points.

Fig. 5 represents a stone tube of a pattern quite different from any of the preceding. It is made of very soft soap-stone, is quite smooth, and accurately outlined. It is four and three-fourths inches in length; one and one-fourth inches in width at the broad, trumpet-mouthed end, and half-an-inch in diameter, where broken. The

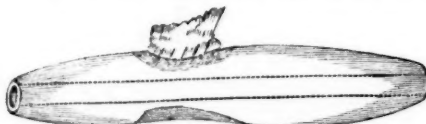


FIG. 4.—One-third natural size.

perforation is one-fourth of an inch in diameter, and of uniform size throughout. Such trumpet-shaped specimens occur elsewhere. Prof. Jeffries Wyman describes one in the Report above quoted, same page. He writes: "A fragment of another tubular instrument of the same ma-

terial (soap-stone) appears to have had a long cylindrical body, and ends in an enlarged and trumpet-shaped mouth, and possibly was used as a horn."

Fig. 5 has faintly engraved upon it a serpent, or what appears to have been one. This representation of a serpent, and the figures on the specimens, Nos. 3 and 4, have probably the same object. Either they represent the owner, the name of the object being that of the possessor of the tube; or, if they were used solely by the sorcerers as "medicine tubes,"¹ wherewith they blew away disease, then the serpent in the one case, and the figures, now undeterminable, on Figs. 3 and 4, were the "gods" or "devils," through whose inspiration the "doctors" effected their cures. How to explain the meaning of the "wings," of Fig. 2, is certainly difficult, if I am correct in my surmises concerning the other specimens; but these may simply be meaningless ornamentation, just as the broken specimen, Fig. 1, when entire, was just as effectual as any in blowing away disease, provided the suffering patient was made to believe so, by entertaining faith in his physician.

A few words in conclusion upon the use of stone drills in boring through stone. There is, in the museum of the Peabody Academy at Salem, Massachusetts, several hundred specimens of stone-drills, all of jasper, and varying greatly in length. These specimens, collected by the writer, have been frequently experimented with, and they are found capable of very rapidly drilling in the minerals of which these tubes and "gorgets" usually are made. And when sand and water are used in addition, it is not extremely difficult to drill in mineral of like or greater density. Stone-drills, such as here referred to, are not flat, like a slender arrow-point, but quadrangular (diamond-shaped) when viewed in section. The points of the few

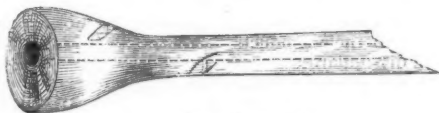


FIG. 5.—One-half natural size.

perfect specimens I have found, were mostly very highly polished, and the sides showed clearly, in some specimens, the action of sand. These drills vary from one to seven inches in length, and from three-sixteenths to over an inch in diameter; or rather the bores they made, had these measurements. Figures of such drills are given in vol. vi. of "American Naturalist," pp. 205-214; also by Mr. Evans, in "Ancient Stone Implements of Great Britain," p. 290, Fig. 230. None of the drills, however, mentioned by Mr. Evans, are large, and are capable only of perforating thin plates of stone. While convinced that a reed, with sand and water was most frequently used in deep bores, I can see no reason for doubting that stone-drills were also used; for such specimens are by no means rare, and no other use can be suggested for them.

The various forms of stone implements found in New Jersey, however specialised, appear to be all traceable to others, far less elaborate, and these ruder patterns, as I have endeavoured to show, are now found at such depths, as a mile, that they may safely be considered as of greater antiquity and the forerunners of the more finished types, the true surface-found specimens. From this fact I have concluded that the red man of the Atlantic coast of North America reached our shores a palæolithic savage, and when discovered by the Europeans had attained to the neolithic stage of culture.

There is one form of stone implement (and only one) that offers an exception to the assumed rule that the ruder antedate the more finished specimens; that is, the

¹ Venegas (Nat. and Civil Hist. of California, vol. i., p. 97. London, 1759) states: "They (medicine men) applied to the suffering part of the patient's body the *chacuaco*, or a tube of a very hard black stone; and through this they sometimes sucked, and other times blew." Quoted by C. C. Jones, junr., in "Antiquities of Southern Indians," p. 363.

smoking pipes. There are no rude or palæolithic pipes occurring in New Jersey, nor, I believe, in any portion of the country. They are all more or less polished and so wrought that they must be classed as a neolithic form of stone implement. Among the chipped unpolished implements of the river gravels I have been unable to find any specimen that could be imagined even to be connected with the custom of smoking. There is, however, abundant evidence of improvement in the flint-chipping art having been attained by the red man while an occupant of this country, readily traced in the axes, arrowpoints, and other forms of weapons and domestic implements; and such advance is not seen in the fashioning of pipes.

For the reasons already stated, I conclude that the custom of tobacco smoking was introduced or established after the red man had attained to the higher division of the Stone age; and that the first pipes were of perishable materials. Such pipes must, I think, have been of wood. Succeeding the use of this, which was necessarily inconvenient, there is reason to believe that a rude clay bowl was attached to the stem, a mere shapeless lump of clay that they would soon learn was rendered somewhat more durable by the exposure to heat. The use of clay bowls might have arisen, too, by the hardening of the earth simply, if the first receptacle for the tobacco was simply a depression in the ground, to the bottom of which was

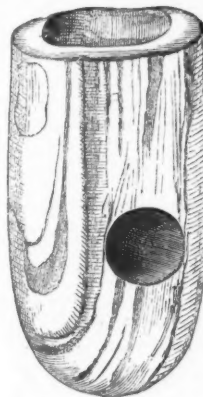


FIG. 6.—Plain Pipe Bowl, natural size.

placed one end of the reed, through which the smoke was drawn to the mouth. However this might have been, I believe I have found fragments of pipes so rude in their shape and coarse in their composition as to warrant the belief that such specimens were the forerunners of the durable stone pipes that now occur in scanty numbers among the relics of the red men of New Jersey.

Inasmuch as the use of clay for pipe bowls was not abandoned, there of course exists a vast range of excellence in the workmanship displayed in their manufacture, and many of the fragments that I have found were as artistically ornamented and made of as carefully prepared clay as others were rude and of the coarsest material. These rudest specimens are never found in graves, and seldom met with except when deeply embedded in the soil, suggesting that they were in use before the custom of burying the smoking pipes of the dead with them was established, and therefore that they antedate the more elaborately finished specimens, which are occasionally found among the deposited relics of "grave-finds;" but such an occurrence is rare in comparison with the presence of stone pipes under similar circumstances.

While the pipe bowls of stone exhibit a considerable range in the excellence of their finish, there is not sufficient variation to warrant one in considering the more rudely finished specimens as the older. They are all well

made and admirably adapted to their peculiar use. Ornamentation was confined, in the vast majority of cases, to the natural markings of the mineral, and not derived from any carving as is so marked a characteristic of the pipes of the mound-builders. Fig. 6 represents a perfect specimen of such plain pipe bowls as I have described. There is no line, straight, curved, or zigzag upon it. The red man who made this specimen had utility solely in view; unless the choice of mineral was considered, as giving beauty to the finished pipe. The material of the specimen figured is a pale green slaty rock, veined with black. The variation in shape of such pipe bowls is of course considerable; and supposing each individual to have

made his own pipe, the shape was in each case decided by the maker's fancy solely. As in the case of arrow-points, of which a score of patterns occur, so with pipe bowls. One will scarcely find two precisely alike; yet the "family likeness" is very strongly marked.

There does occur, however, a second form of smoking pipe, but much more sparingly than the preceding, differing greatly, both in size and shape. While the two patterns occasionally approach in general outline, they do not do so sufficiently to warrant our considering the one to pass into the other form.

This variety of pipe, of which Fig 7 is an example, is well known as the calumet or "peace-pipe." The bowl

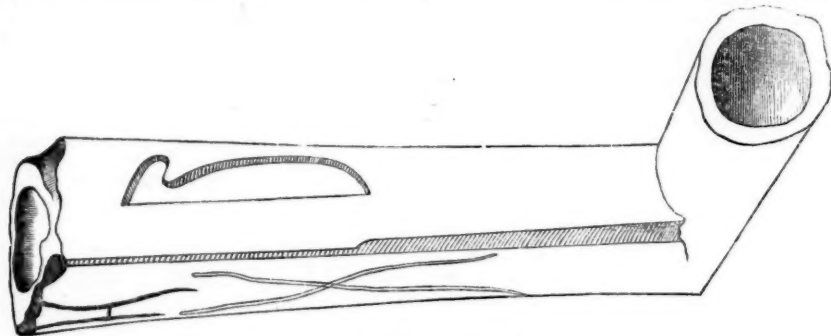


FIG. 7. - Calumet, natural size.

in this case, as a rule, is much smaller, and the labour of the maker has been expended upon the stem-like base, which in every specimen I have seen has been quite elaborately ornamented. The specimen figured is not as much carved as many, but being quite perfect, is represented in preference to fragments of others.

I believe no specimens of "animal pipes," such as are found in the Mississippi valley, have been found in New Jersey, which fact is interesting, as there is much reason for believing that when the mound-builders occupied the western valleys the red man was already occupying the Atlantic coast; and doubtless some trading was carried on between the two peoples. Therefore, it would be natural to expect that such pipes should occur among our Indian relics; or at least that there was sufficient

knowledge concerning them to suggest to the coast Indians the idea of imitating them; but there is no trace of such imitation I believe. It is their smoking pipes alone, of all their productions in the flint-chipping art, that are dissimilar.

Through the writings of the earlier missionaries we learn of the peculiar uses and significance of these calumets, which formed so prominent a feature on all important occasions; but whether they were introduced by some other race with whom the red man came in contact, or originated *de novo*, it is impossible to determine; but it is quite certain that the specimens so far brought to light do not enable us to trace the evolution of the calumet from the simpler form of pipe.

Trenton, N.J., U.S.A., May 6 CHAS. C. ABBOTT

NEW METEOROLOGICAL LABORATORIES AT MONTSOURIS

M. MARIÉ DAVY, Director of Montsouris Observatory, has organised, partly at the expense of the French Government, partly at the expense of the City of Paris, a chemical and microscopical laboratory for the analysis of all the matters in suspension in the air of Paris, both quantitatively and qualitatively. A certain quantity of air is constantly aspired by an aspirator in continued operation. The ozone acting on iodide of potassium and starch liberates iodine. The quantity of ozone liberated is measured by a titrated solution of arsenite of sodium. The matters in suspension are collected on a glass plate, and the crop is placed under the object-glass of a powerful microscope magnifying 1,000 times. The principal forms are drawn and plates are executed and published monthly in the Transactions of the establishment. The analysis of rain-water is conducted on the same principles, and the results of chemical analysis are calculated and compared with the wind and other atmospheric circumstances.

We are indebted to M. Marié Davy for the principal results of the month of February, the first period for

which the whole system has been put into complete operation.

The electrical department has been fitted up, after a preliminary trial, and has been in working order for some time. In order better to illustrate the importance of these researches we take the liberty of altering the figures in order to give the results in round numbers for the whole area of Paris within the fortifications. The surface is about 80,000,000 square metres. In February 1876 the quantity of atmospheric water was 4,500,000 cubic metres. This is about double the average, but in some years on record the quantity was even larger, in 1776 a century ago, it was more than 6,500,000 cubic metres. In taking as an average the analyses of rain-water at Montsouris, the 4,500,000 cubic metres contained 4,700 kilogrammes of nitric acid and 10,700 kilogrammes of ammonia. This mass of nitric acid is supposed to have been produced by electrical reactions in the atmosphere, and ammonia only partly, as Montsouris is in the southern part of the city, close to the fortifications.

The 4,500,000 cubic metres of rain water were also proved to contain 172,000 kilogrammes of organic matter, and 88,400 kilogrammes of metallic salts or products. A number of organic matters have been found

to be composed of spores, parts of animalculæ, and even living infusoria. Amongst the metallic salts we must mention particles of meteoric iron, evidently of cosmic origin. It is contemplated by the city of Paris to establish similar observations in several parts of the city, and the careful comparison of these analyses will prove invaluable for establishing a number of most interesting facts having a bearing on the welfare of inhabitants, as well as on the elucidation of important scientific problems.

It is also contemplated to make use of aeronautical ascents to test the air at any altitude accessible to a balloon with horizontal glass plates covered with glycerine. The moisture of the clouds is to be condensed on glass tubes which will be refrigerated.

The ozone testing and measuring has produced also startling facts. Although the quantity of ozone is very minute, amounting to only a few milligrams per 1,000 cubic metres, it has been proved that on Feb. 27, the day of the ozone maximum, a quantity of 900 kilog. was floating over Paris, if we suppose that the quantity was the same as at Montsouris in the whole stream of air passing above up to the altitude of 1,000 metres.

These results are only a sample of those which may be expected from the constant application of the magnificent system which is now brought into operation for the first time, and of which it will be possible to say, *Vires acquirit eundo*.
W. DE FONVILLÉ

NOTES

THE following are the arrangements for the Free Lectures in connection with the Loan Collection of Scientific Apparatus for the next few weeks. The lecture hour is eight P.M. Saturday, June 17, Mr. W. H. Preece on Telegraphic Instruments; Monday, June 19, Mr. Kempe on the Application of Linkages to Machinery; Saturday, June 24, Capt. Abney, F.R.S., on Photographic Printing Processes; Monday, June 26, Dr. Schuster on Ampère's and Faraday's Instruments; Saturday, July 1, Mr. W. C. Roberts, F.R.S., Graham's Apparatus and what he did with it; Monday, July 3, The Right Hon. Dr. Lyon Playfair, C.B., F.R.S., Otto von Guericke's and Black's Instruments; Saturday, July 8, Dr. Gladstone on the Instruments lent by the Royal Institution.

ON the 1st inst. the Society of Arts of Geneva celebrated the first centenary of its existence. Founded in 1776 by H. B. De Saussure and some of his friends, it has continued ever since to render real service to Switzerland in the departments of Arts, Industry, Commerce, and Agriculture. Without having any direct connection with science, it has always, however, been associated with it, and all the scientific men of Geneva have from time to time taken a share in its proceedings; the Pictets, De Candolles, De la Rives, and other well-known names, have at various times been presidents. A prize founded by Aug. De la Rive, to be awarded to the discovery most useful to Genevese industry, is intrusted to the care of the Society. In order worthily to celebrate the centenary, the Society had announced various competitions in the different branches with which it is connected, and which appealed to all manufacturers of horological instruments. The nature and terms of this competition we announced last October (vol. xii., p. 525). It was an international competition in chronometry, in which there was a large number of competitors, and of which the results have been now made known. A Prize of Honour was awarded to M. Ulysse Nardin, of Locle, Neuchâtel; six equal First Prizes were awarded to M. H. R. Ekegrin, of Geneva, Messrs. Parkinson and Frodsham, of London, Messrs. Badollet and Co., Geneva, Predard et Fils, Geneva, M. Ed. Perregaux, of Locle, and M. Fritz Piguet, of Geneva; other awards were likewise made. After the general meeting and the distribution of prizes, a banquet was held, at which about four hundred members of the

Society were present; this was followed by a conversazione on the terrace of M. Th. De Saussure, grandson of the celebrated naturalist, the founder of the Society, on the very place where the first meeting was held a century ago.

AT the meeting of the Royal Geographical Society on Monday, Sir Rutherford Alcock, the new president, in the chair, a paper by Mr. E. D. Young, R.N., was read, on a journey to the northern end of Lake Nyassa. The cruise round Lake Nyassa had occupied a month, and the area was much larger than Dr. Livingstone thought, the north end extending to 9°20' S. lat. In most parts it was very deep, and in several places no bottom could be found with 100 fathoms of line. A range of mountains nearly 100 miles in length, extended above the lake, some reaching an elevation of 10,000 or 12,000 feet. There were also numerous rivers running into the lake, but none navigable for any distance. At some parts there were numbers of villages built on piles in the lake; many people in other parts living on barren rocks. Mr. Young added that he intended to be back to England in a few months, and would in the meanwhile make a more perfect survey of the lake and give the results to the Geographical Society on his return. A paper on "The Valley of the Tibagy, in Brazil," by Mr. T. B. Wither, C.E., was also read. The author of the paper was engaged in conjunction with others, in August, 1871, in exploring that section of the Ivahy Valley which lies between Colonia Theresa and the Corredeira de Ferro, or "Iron Rapid."

THE University of Oxford proposes to confer the degree of D.C.L. upon the following, among others:—Prof. W. H. Miller, F.R.S., Prof. J. Clerk Maxwell, F.R.S., Dr. Samuel Birch, and Lieut. V. L. Cameron.

THE Oxford University Bill was read a second time in the House of Commons on Monday. In the debate which followed there was nothing worthy of comment.

THE annual conversazione of the Society of Arts will be held at South Kensington Museum on Friday, the 23rd inst.

IN a recent issue of the Italian medical journal *L'Imparziale* laments that the unjust and ridiculous accusations of a number of strangers resident in Florence and of an exceedingly small minority of the inhabitants should have induced Prof. Schiff to accept the chair which has been offered to him at Geneva. The loss to physiology in Italy will be so great that, according to a communication in the *Daily News*, the *Bersagliere* believes that the Minister of Public Instruction will use every endeavour to make the illustrious physiologist withdraw his resignation.

EXCELLENT accounts have been received from the German North Asiatic Expedition, which has arrived as far as Semipalatinsk, in Siberia, and has obtained living specimens of the large Argali sheep (*Ovis ammon*) of Linnaeus.

THE veteran ornithologist, Dr. Hartlaub, has in preparation a new work upon the Ornithology of Madagascar and the adjacent islands. Since Dr. Hartlaub's original memoir on this subject was published in 1861, since which time, Pollen, Van Dan, Crossley, Grandidier, and others, have done much to increase our knowledge of the avifauna of Madagascar.

WE hear from Sidney that the sum of 800*l.* had been raised towards Signor D'Albertis' expedition up the Fly River, New Guinea; and that he was intending to start from that city on the 19th of April with the steam-launch loaned to him by the Government of New South Wales.

WE regret to hear that the strife at Sidney about the dismissal of Mr. Kreffit from the post of Curator and Secretary of the Australian Museum is not over. The subject came before the Legislative Assembly on the 6th of April, and provoked an

angry discussion. Mr. E. P. Ramsay has been installed by the trustees as Mr. Krefft's successor, and is in full work; but the Supreme Court has decided that the trustees had no real authority to remove Mr. Krefft. Whatever the issue may be, everyone acquainted with the case must hold that Mr. Krefft deserves fair and liberal treatment as one of the few naturalists in Australia that have done good original work in spite of many surrounding difficulties.

On June 7 a violent thunderstorm occurred at Valbonne, a large plain at a little distance from Lyons. The only objects struck were huts full of soldiers and arms, and the occurrence furnishes a good instance of the "power of points" and the attracting power of metals and living beings for lightning. Three tents were struck in succession. The occupant of the first was absent at the moment, and the effects were relatively slight, producing only the breaking of stones and dispersing of dust. In the second instance a soldier who was standing erect in front of one of the tents was struck; but the tent being located in the vicinity of an electric telegraph the lightning escaped by it, fired the wires, and broke a dozen poles. This may suggest a very easy method for protecting an encampment. The third flash struck a number of tents placed in a zig-zag line, doing much damage, several of the occupants being either killed or wounded. In one tent three men were killed and seven wounded. All of them were either touched in both legs or on the right side except one, who was wounded in the right eye. In another tent four men were wounded, all of them in both legs or in the left one. In other instances men were turned round in or heaved out of their beds. In all the instances referred to the men were lying on their beds, made of iron, and the sentry standing in front remained unhurt. In one tent a man, who was lying between two men who were killed, escaped unhurt. The uniforms of the soldiers were perforated and exhibited small spots; one, four centimetres in diameter, entirely sulphurised. A chemical analysis will be made of this part of the uniform, and the result communicated to the Academy of Sciences.

At a meeting of the Cymmrodorion Society held last Friday, in the Memorial Hall, Farringdon Street, Prof. F. W. Rudler, F.G.S., read a paper on "Natural History Museums, with Suggestions for the Formation of a Central Museum in Wales."

THE boring of the shafts for the Anglo-French tunnel is progressing favourably. A pump has been erected for the draining of the works. Water has been already met with in abundance, although the depth reached is only 40 feet. The intended level is 60 feet further down.

THE Edinburgh Town Council, it is stated, have agreed to apply to the Government for aid to the building fund of the University extension scheme, and to memorialise in favour of a parliamentary grant. The Council had previously subscribed 1,000 guineas to the fund on their own account.

THE Geographical Society of Paris has received good news from the Gaboon expedition. Lieut. Brazza and M. Marche have located themselves at Okanda, 500 miles from the mouth of the Ogowe, and are establishing permanent settlements and ready means of communicating with the factories on the coast. They lost a part of their baggage and goods in crossing rapids, but having been enabled to send messengers to the French Gaboon settlement they will recover from their losses and will proceed further in the untrodden region.

ON June 8 the French Society of Amis des Sciences held its annual meeting at Paris. M. Bert gave a lecture on the *Zenith* balloon catastrophe in connection with the inhalation of oxygen. This Society was founded by the Baron Thenard for assisting scientific men in their work and their families after their death.

THE French Society for Encouragement of National Industry had to vote this year the great Prony prize for the most useful invention in mechanics discovered during a certain number of years. The award was made to M. Henry Giffard, of Paris, the aeronaut, for the invention of his injector, used in all locomotives. The invention is fifteen years old, and the patentee has realised through this his single invention a fortune falling very little short of half a million sterling.

WE take the following from the *Geographical Magazine*:—Dr. P. Ascherson left Benisuef for Medinet-el-Fayum, on March 16, and started from the latter place on the 24th, en route for the Little Oasis, the botanical exploration of which constituted the object of his journey. On April 1 he reached Bahiti, the present capital of the Oasis parva, by the same route as that followed by Belzoni in 1816. This journey proved that no "Bahr bela ma" or old river-bed exists in that portion of the Libyan Desert. After an exhaustive exploration of the oasis, Dr. Ascherson started on May 1 on his return journey, travelling by an entirely new route, and reaching the Nile at Samalut. The botanical exploration of the oases of the Libyan Desert begun two years ago by Dr. Ascherson, whilst a member of Rohlf's expedition, has thus been terminated, and several facts of great interest have been ascertained during this last journey as regards the Fayum, as well as the Little Oasis. Several species of plants, met with far to the east and south-west, in Asia, but not in the Valley of the Nile, or in the deserts to the east of it, occur also in the oases. Some of the more remarkable of these plants are *Dianthus Cyri*, *Populus euphratica* (= *P. diversifolia* of Mongolia), and *Prosopis Stephaniana*.

THE Society of Ethnology of Paris has proposed, for 1876, a prize to the best memoir on "The Slavonic Race, and Maps of the Countries inhabited by Slavonians." The prize will be awarded in December, and the memoir may be written in English as well as in French and in several other languages, not excluding Polish and Russian.

THE twenty-fifth Annual Educational Conference of the Society of Arts will take place on June 23, at 11 o'clock. The chair will be taken by Sir Henry Cole, K.C.B. With the view of giving special interest to the Conference this year, the Council have decided that the subject of adult education, especially in reference to technical instruction and its promotion by the action of the Government, shall form the principal subject for discussion.

PROF. E. QUETELET has written a brief notice in the *Bulletin* of the Royal Academy of Belgium, of the storm of March 12, 1876, which was the most violent hitherto observed at Brussels, the wind having reached the enormous pressure of 144 kilogrammes per square metre, or nearly 30 lbs. per square foot, and the barometer fallen to 28.560 inches at sea-level, having only once fallen below this point since the founding of the Observatory in 1833. We are glad to see that Dr. Buys Ballot is also examining this remarkable storm, which he will be able to do very fully owing to the number of registering barometers in operation at the Dutch Meteorological Stations.

In the *Supplemento alla Meteorologia Italiana*, anno 1875, fasc. ii., there appears a very valuable paper, by P. F. Denza, on the distribution of the rainfall in Italy during 1872. The paper, which is one of great ability, details the rainfall of that year, comparing it where possible with the averages of past years; and in consideration of the singular diversity with season of the rainfall of the different parts of Italy, the stations are classed according to five zones, viz., Alpine, Pre-alpine, East Apennine, West Apennine, and Sicilian. The details of the great rains of October 1872 are very interesting, the amount for the month being 40 inches at Pallanza, 41 inches at Crabbia,

49 inches at Scopello, and 69 inches at Oropa. The two absolutely largest daily falls occurred on the 5th, viz., 8.9 inches at Crabbia, and 9.1 inches at Mesma. Part iv. of the paper deals with the general causes determining the rainfall of Italy and the application of the results in explanation of the mode of the peculiar distribution of the rainfall over Italy during 1872.

MACMILLAN AND CO. will shortly publish the second part of Mr. Pickering's "Physical Manipulation."

THE annual meeting of the Aëronautical Society was held on the 7th inst., Mr. Charles Brook, F.R.S., presided. A paper was read by Mr. D. S. Brown on the advantage of applying power for aerial propulsion in an intermittent manner, and on the soaring of birds. Another paper by Mr. Armour, C.E., on air compression under wing-planes, was read.

THE fiftieth anniversary of the Société Industrielle de Mulhouse has been celebrated by an Exhibition of the Arts and Manufactures of Alsace. M. Perrot, one of the original founders, read the report, which showed that the Society has had a prosperous and useful career. Papers were read on the electric light, illustrated by the illumination of the banquet hall by electricity; on steam-engines; on borings at a great depth executed in Alsace; on electro-chemical experiments made on benzol. The meeting was a most successful one.

THE following additions have been made to the Royal Westminster Aquarium during the past week:—Young Green Turtle (*Chelonia viridis*) from the Island of Ascension, presented by officers of the Challenger expedition; Monk-fish (*Rhina squatina*); Blue and Red Wrasse (*Labrus mixtus*); Greater Weever (*Trachinus draco*); Horse Mackerel (*Trachurus trachurus*); Angler-fish (*Lophius piscatorius*); Gattoruginous Blenny (*Blennius gattorugine*); Red Gurnard (*Trigla lyra*); Grey Gurnard (*T. gurnardus*); Streaked Gurnard (*T. lineata*); Lump-fish (*Cyclopterus lumpus*); Sea Lamprey (*Petromyzon marinus*); Mud Lamprey (*Ammocetes branchialis*).

THE additions to the Zoological Society's Gardens during the past week include among others, a Mexican Deer (*Cervus mexicanus*) from S. America, presented by Mr. Thos. B. Forwood; two Spur-winged Geese (*Plectropterus gambensis*) from S. Africa, four Galapagan Tortoises (*Testudo elephantopus*) from the Galapagos Islands, deposited; a Humboldt's Lagothrix (*Lagotherix humboldti*), an Ocelot (*Felis pardalis*), a Tayra (*Galictis barbara*) from S. America; a Great Barbet (*Megalania virens*), from the Himalayas, purchased.

LOAN COLLECTION OF SCIENTIFIC APPARATUS

SECTION—MECHANICS

PRIME MOVERS¹

HAVING thus mentioned the earliest record of hydraulic (or indeed of any) prime movers I will not endeavour to trace their history down to modern times, as it would be impossible to do so usefully within the limits of an address. I will therefore now ask you to join me in considering what are the conditions which govern the application of water to hydraulic prime movers.

After all water must be looked upon as a convenient form of descending weight. When the fall is not great it is always practicable by means of water-wheels having buckets which retain the water to employ, as I have said, its mere gravity, and probably it is by this mode that the highest result is procured from any given quantity of water falling through a given height. By the use of a backshot wheel as much as 75 per cent. of the total power is obtainable. The 25 per cent. of loss arises from the friction of the axle of the wheel and of the gearing transmitting the force to the machine which is to utilise it, from some of the

water being discharged out of the buckets before the bottom of the fall is reached, from the necessary clearance between the wheel and the tail water, from the eddies produced in the water as it enters the buckets, and (to a certain small extent) from the resistance of the air.

When the difference of level between the source of water and its delivery exceeds, however, 40 or 50 feet, the water-wheel becomes so unwieldy and expensive and revolves so slowly that it ceases to be a desirable prime mover; recourse can then be had to water-pressure engines, engines wherein pistons move in cylinders and being pressed alternately in opposite directions by the head of water set up rotary motion in the machine in the same way as if the pistons were acted upon by steam. In the construction of such water-engines great care must be taken to have ample inlets and outlets in order that the loss incurred either by the power requisite to drive the water through restricted orifices, or by surface resistance caused by a too speedy flow along the various passages may be a minimum. Care has to be taken also in the arrangements of the valves that the engines, when employed for rotatory movement, may be able to turn their centres without producing an injurious pressure upon the water within the cylinders. Water-engines employed for pumping, but without rotatory movement, are mentioned by Belidor in his "Architecture Hydraulique," published in 1739, article 1, 156. In England Sir William Armstrong has brought these machines to great perfection. The first of these, erected many years ago, is still working most successfully at the Allan Head Lead Mines. This machine is driven by a natural head of water and not from an accumulator, and is employed in the mine as a winding engine.

An extremely useful feature in engines of this kind is their adaptability to be driven by the pressure of water derived from an ordinary water-works, and in this manner small manufacturers carrying on business in their own houses are enabled to obtain a prime mover with great ease, and, all things considered, at small cost. Not only is advantage taken of such machines for the purpose of driving manufactures, but water cylinders are now largely employed for working the bellows of church organs, for which purpose an overshot water-wheel is shown as being employed as far back as Solomon de Caus's book, date 1615.

Large water-wheels, or even water-engines, are comparatively costly machines, and as large water-wheels make but few revolutions per minute, they require, as has been said, expensive and heavy gearing to get up speed; thus it is that it frequently becomes a desirable thing to dispense with such machines and to resort to other modes of making available high falls of water. In former times this was done by suffering the impetuous stream of water to beat upon the pallets of water-wheels, but from such machines only a poor effect could be obtained, as a large portion of the energy in the water was devoted to the formation of eddies and the generation of heat, and to the production of lateral currents, leaving but a small percentage available as motive power.

Much of the evil effect, however, attendant upon using the impact of water as a means of driving water-wheels is obviated by the construction invented by the distinguished French engineer Poncelet. For high falls, however, the implement now generally employed is the turbine, of which the well-known Barker's mill may be looked upon as the germ.

I have got before me No. 1,983, a model of Fourneyron's turbine.

This is not an apt model for my present purposes, inasmuch as it is one to be employed with a comparatively low fall of water, but even in such instances the turbine gives most excellent results, and it has the advantage over the water-wheel of being able to work with great efficiency although there may be a considerable rise in the "tail water," a rise which would materially check the action of an ordinary water-wheel. In this turbine every care has been bestowed to give a proper form to the pallets on which the water acts so as to take up step by step as it were the whole of the energy residing in the stream, so that the water may pass away from the turbine in an inert condition, and so that in acting upon the vanes of the turbine, eddies may not be formed and thus energy may not be wasted.

There are probably few sights more surprising to the old-fashioned mechanic, who has been used to see water-wheels of 50 or even 70 feet diameter employed for the utilisation of a high fall, than that of a turbine occupying only a few cubic feet of space but running at such a velocity as to consume the whole of the water of a considerable stream, and so to consume it as to deliver nearly as large a percentage of useful effect as would the cumbersome water-wheel itself.

¹ Address delivered by F. J. Bramwell, C.E., F.R.S., one of the vice-presidents of the Section, May 25. Continued from p. 147.

If the object is merely to raise water this can be done without the employment of either water-wheel or turbine. When a small quantity is required to be raised to a considerable height the Montgolfier ram is employed. No. 1,996, which I have before me, is a glass model of such a ram, but I fear it is too small to be visible, except to those who are very near to the table. You are, however, all aware that the principle of action consists in the sudden arrestment of a column of water flowing with a velocity due to the head. The water on being arrested performs two functions, a small portion raises an outlet valve, and thereby passes into an air-vessel against a pressure competent to drive the water up to the desired height; while the main body recoils along the supply pipe; then, the escape valve having opened the water that has recoiled, returns, a large portion passes out of the valve, and thus the velocity being fully established the escape valve shuts and causes another arrestment and a repetition of the working. This is an implement by which a large volume of water coupled with a low fall, can be made to raise a portion of itself to a great height. But there is a converse use of water, wherein the employment of a small stream of water moving rapidly (owing to its having fallen from a considerable height) is caused to induce a current in other water and to draw it along with itself at a diminished velocity but still with a velocity competent to raise the united stream to a less height, and in this manner many swamps and marshy lands have been drained.

This employment of the induced current as a prime mover is described by Venturini in the record of his experiments made at the latter end of the eighteenth century, and within the last few years Mr. James Thomson has applied the same principle with great success in his jet pump.

The next mode I shall notice of obtaining motive power from water, is also one where it operates by an induced current; this is the "Trombe d'eau," an apparatus wherein water falling down a vertical pipe, induces a current of air to descend with it. The lower end of the vertical pipe being connected with the upper side of an inverted vessel, the bottom of the sides of which vessel is sealed by a water joint, then the water dashing upon a block placed below the mouth of the pipe, is separated from the air, so that while the water descends and escapes from under the sides of the vessel, the air rises and accumulates in the upper part from whence it can be led away to blow a forge fire. These machines are described in Belidor's work.

The utilisation of the rise and fall of the tide is also fully described by Belidor, who gives drawings of channels so arranged that during both the rise and fall of the tide the wheel, notwithstanding the reversal of the currents, revolves in one and the same direction. The tide is a source of power which it is highly desirable should be utilised to a greater extent than it is; if we consider the enormous energy daily ebbing and flowing round our shores, it does seem to be a matter of great regret that this energy should be wasted, and that coal should be burnt as a substitute.

The last mode in which power may be obtained from water, to which I have to allude, is that of the employment of the waves.

Earl Dundonald, better known as Lord Cochrane, proposed by his patent of 1833 to utilise this power for propelling a vessel; this he hoped to accomplish by the use of cylinders containing mercury, the oscillations of which were to cause a vacuum condition in the cylinders, and thereby give motion to an air-pressure engine. Late'y we have had produced before the Institution of Naval Architects, and also before the British Association at Bristol, the apparatus of Mr. Tower, by which the motion of the waves is to be utilised; a model constructed on this principle has driven, it is said, a boat against the wind at some two or three miles an hour.

The next kind of prime-movers in order of date to be considered, are those that are worked by the wind.

Although undoubtedly the propelling of a ship by sails, and even the winnowing of grain, must have long preceded the invention of a prime mover driven by water, yet the employment of the wind as a source of motive power for driving machinery, appears to be but of comparatively recent date. It is said that the knowledge of this kind of prime mover was communicated to Europe by the Crusaders on their return from the East, but it is difficult to see what foundation there is for this statement. It appears to be certain, however, that wind-motors were commonly employed in France, Germany, and Holland in the thirteenth century.

We can easily understand that in countries where water falls in quantities and rapid streams are abundant, the windmill would

not, owing to its uncertainty, be resorted to; on the other hand, in inland countries and in countries like Holland, where the streams are sluggish, and where there is a large amount of land to be drained, the wind, although still uncertain, would nevertheless be a valuable power, and therefore would be utilised.

Prime movers to be worked by the wind appear to have been made practically in only two forms, viz., the common one, wherein a nearly horizontal axle carries four or more twisted radial sails, and that one wherein the axle is vertical and the arms project from it laterally either as radial fixed arms, as curved fixed arms, or as arms having a feathering motion similar to that of paddle-wheels. Where the arms are straight and fixed, some contrivance must be resorted to to obtain a greater pressure of wind on one side than on the other.

Bessoni, in his work "The Theatre of Instruments and Machines," published at Lyons in 1582, describes a windmill with vertical spindle and curved horizontal arms, placed in a tower with a wind-guard, and by the drawing shows it working a chain-pump. Belidor also says in Article 852 that windmills with vertical axles were well known in Portugal and in Poland, and he describes how that they work within a tower the upper part of which was fitted with a movable portion to act as a screen to one side of the mill.

I will not detain you by an allusion to the sailing chariot mentioned by my Uncle Toby in "Tristram Shandy," nor will I pause to describe the very modern one, that is to say, not more than about thirty years old, which was employed upon Herne Bay Pier. In fact this Exhibition gives but little encouragement to pursue the subject of prime-movers worked by wind, as I have not as yet come across in the Catalogue any apparatus illustrative of the subject.

It is to be regretted that the use of this kind of prime mover, the windmill, is on the decline. It is a power that costs nothing; the machinery can be erected in almost any situation; and although such a motor cannot by itself be depended on, being of necessity "as uncertain as the wind," it nevertheless might be commonly employed as an auxiliary to steam-power, diminishing the load upon the engine in exact proportion as it was urged by any wind which might happen to blow.

I may say, to the credit of our American brethren, that they employ on their sailing-ships a windmill known by the sailors as "The Sailor's Friend," to pump, to work windlasses, and to do all those matters which in a steam-ship fall to the lot of the donkey-engine and steam winch, unless, as in a recent voyage in which all Englishmen have been so much interested, these duties were imposed upon the baby elephant.

There is one motor which may be put either into this class or into the next, where we consider the application of heat; I allude to the smoke-jack, but beyond recognising its existence as a prime mover, and a very early one indeed (it is to be found in Zoncas' work published in 1621), attention need not be bestowed upon it.

We now come to consider those prime movers which are worked by the immediate, and not by the secondary, action, of heat.

The direct rays of the sun have, for a very long time past, been suggested as a means of obtaining motive power. Solomon de Caus in his work, published in 1615, describes a fountain which is caused to operate by the heat of the sun's rays expanding the air in a box and expelling thereby, through a delivery valve, the water from the lower part of the box. When the sun's rays have been withdrawn, the air, cooling, contracts a suction valve, opens and admits more water into the box to be again displaced on the following day. He also gives a drawing of an apparatus where the effect of the sun's rays is to be intensified by a number of lenses in a frame. Solomon de Caus proposes these machines as mere toys to work an ornamental fountain, but Belidor, by Article 827, describes and shows a sun pump consisting of a large metallic sphere, fitted with a suction pipe and valve, and a delivery pipe and valve and occupied partly by water and partly by air, the suggestion being as in the case of Solomon de Caus, that the heat of the sun in the daytime expanding the air should drive up the water into a reservoir, while the contraction of the air in the night-time should elevate the water by the suction pipe and recharge the sphere for the next day's work. In modern times, as we know, some attempts to obtain practical motive power from the direct action of the sun have been made, and notably by Capt. Ericsson.

The temptation to endeavour to bring into practical use a machine of this character is very great. We were told by our

President, in a lecture delivered by him to the British Association at Bradford, that the solar heat, if fully exercised all over the globe, supposing that globe to be entirely covered with water, would be sufficient to evaporate a layer 14 feet deep of water per annum. Now assuming 10 lbs. of water evaporated from the temperature of the air into steam by the combustion of 1 lb. of coal (a much larger result than unhappily is got in regular work), this would represent an effect obtained from the sun's rays on each acre of water equal to the combustion of 1680 tons of coals per annum, or to about 92 cwt. of coal per acre per twenty-four hours; or enough to maintain an engine of 200 gross indicated horse-power day and night all the year round. When, however, we consider the effect of the sun, not upon the surface of water but upon the earth, and deal with its power of producing heat-giving material, the result compares very unfavourably with the work done by the sun itself; and this, no doubt, arises first, from the fact that the sun is frequently obscured, and second, from the fact that a large portion of the energy of the sun is spent in evaporating moisture from the ground, and not in the direct production of combustible material. I have found it extremely difficult to obtain any reliable data as to the weight of fuel grown per acre per annum. If we take the sugar cane, we find that in extremely favourable cases as much megass and sugar together are produced as would equal in calorific effect about five tons of good Welsh coal. Coming to our own country and dealing with a field of wheat, the wheat and straw together may be taken as being equal probably to about two tons of coal as a maximum. The statements made to me with regard to the production of timber per acre per annum, when grown for the purpose of burning, are very various; but the best average I can make from them is that in this country there is produced as much wood as is equal in calorific effect to about 14 tons of good coal per acre. Comparing these productions of heat-giving material with the energy of the sun, as shown in the evaporation of water, one shows how tempting a field is that of the direct employment of the solar rays as a source of power; more especially, when it is remembered that those rays are obtained from week to week, and year to year, without having to wait the tardy growth of the fuel-dead tree.

I will now ask you to consider with me the prime movers that owe their energy to the heat developed by the combustion of some ordinary kind of fuel—coal or wood. Passing by as a mere toy and not an actual prime mover, the reactionary steam sphere, the eoliopile of Hero, I will come at once to those simple forms of heat-engine (whether worked by steam or the expansion of air), by which water was to be raised. Solomon de Caus, in his work of 1615, already mentioned, says that if you fill a globe with water and have in its upper part a pipe dipping nearly to the bottom, and if you put the globe upon the fire the heat will cause the expansion of the contents, and the water will be delivered in a jet out of the tube.

The Marquis of Worcester in his "Century of Inventions," published in 1659, makes, as is well known, a similar proposition, but it does not appear that these machines were seriously contemplated for practical use. Papin (I take Belidor's Article No. 1,276 as my authority) in 1698 (as appears in his pamphlet of 1707) experimented by order of Charles the Landgrave of Hessen Cassel with the view of ascertaining how to raise water by the aid of fire. But his experiments were interrupted and he did not resume them until Leibnitz, by a letter of Jan. 6, 1705, called his attention to what Savery was doing in England, sending him a copy of a London print of a description of Savery's engine. This engine, which of course is well known to you, is illustrated by a model in this collection, and now on the table before me. Savery employed a boiler, the steam from which was admitted into a vessel furnished like the sun-pump of Belidor with a suction pipe and clack and a delivery pipe and clack; the steam being shut off, cold water was suffered to flow over the vessel, a vacuum was made and water raised into the vessel, which was expelled out of the delivery pipe upon the next admission of steam, the cocks being worked by hand. This machine came into very considerable use and was undoubtedly the first practical working steam-engine. It had, however, the defect of consuming a large quantity of steam, as the steam not only came into contact with the cold vessel but also with the surface of the water in that vessel. Papin, as we know, obviated a portion of this loss by the employment of a floating piston placed so as to keep the steam from actual contact with the surface of the water.

We have in the collection, No. 2,007, a cylinder from Hessen Cassel, said to be of the date of 1699 and to have been intended

for employment in Papin's machine, but it is difficult to say for what part of the apparatus it could have been designed, inasmuch as the cylinder is provided with a flange at one end only and no means, so far as I can ascertain, exist for closing the other end. You will see from the diagram that which no doubt is already well known to you; Papin did not propose to condense the steam, and by its condensation to "draw up" the water (to use a familiar expression) but intended that the vessel should be charged by a supply from above, and that the steam should be employed only to press on the floating piston and to drive the water out. Papin, however, hoped to use his engine, not merely as a water-raiser, but as a source of rotary power by allowing the water to issue from the air vessel, so as to impinge upon the pallets of a water-wheel and thus produce the required revolution.

(To be continued.)

SCIENTIFIC SERIALS

American Journal of Science and Arts, May.—Mr. Holden here collates various observations made on nebula M 17 (the figure of which is like that of a Greek capital Omega) from 1833 to 1875. The drawings show that the western end has moved relatively to its contained stars, and always in the same direction. It may be a veritable change in the structure of the nebula itself or the bodily shifting of the whole nebula in space.—Mr. Trowbridge states that the application of thin plates of soft iron on the poles of two straight electro-magnets, with bundles of fine iron wires for cores, increases the strength of the spark at the poles of two secondary coils surrounding the electro-magnets, 400 per cent. The length of the spark is increased 100 per cent. (but this is only manifested by using Leyden-jars of large capacity with the secondary circuit). Instead of distributing the fire wire of a Ruhmkorff coil on a straight electro-magnet, as at present, it should be distributed equally on two straight electro-magnets whose poles are provided with armatures of bundles of thin plates of soft iron.—Mr. Wilson having applied infusorial earth to land sown in wheat, afterwards treated some of the wheat straw with nitric acid, and found that the siliceous remains consisted almost wholly of the shields of diatomaceæ, the same as found in the infusorial earth (only the larger discs, in their perfect form, being absent). It would appear that simple or compound silicates are useless as fertilising agents, and that silica can enter the plant only in the free state.—In the first portion of a paper on the solid carbon compounds in meteorites, Mr. J. Laurence Smith, after noting that in carbonaceous meteorites the mineral constituents are mainly the same as in the so-called common type of meteoric stones (viz., olivines, and pyroxenes, differing only in the more or less compact form of these minerals), shows, that even in the carbonaceous constituent they are strongly linked even to the iron meteorites.—Mr. Fontaine continues his account of the conglomerate series of West Virginia; Mr. Dana describes new forms of staurolite and pyrrholite; and we also find chemical notes on phosphorus oxychloride, and the oxydation product of glycogen with bromine, silver oxide, and water.—A simple and very accurate method of testing the unison of two forks is (according to Mr. Spice) by holding them together over their proper resonant column; if the forks be very nearly in tune, beats will be perceived succeeding each other at long intervals, or the sound will merely swell out again very slightly after it has nearly died away. When the forks are absolutely alike, there will be a gradual decrease of sound down to silence, without any reinforcement at any time.

THE *American Naturalist* for May commences with an article by the Rev. S. Leckwood, on Animal Humour. Prof. Asa Gray writes on Wild Gooseberries. Hon. J. D. Cox describes multiplication by fission in *Stentor mülleri*. An article on Primitive man follows, after which Mr. A. S. Packard, jun., describes and figures the Cave-beetles of Kentucky. Prof. Farlow writes on University Instruction in Botany. General Notes and a few short reviews follow, the number being completed by notes and notices of meetings.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, March 1.—This number contains a long article on the relations of temperature and moisture in the lowest atmospheric strata during the formation of dew, by Dr. R. Rubenson, of Stockholm. Observations made by Dr. Hamberg, at Upsala, on temperature at different heights on frosty nights led him to conclude that in the lower strata temperature increases with height, and that the

absolute moisture is less on the ground than a few feet above it. The chief results obtained by Dr. Rubenson during the summer of 1871, by a method of observation differing from that of Dr. Hamberg, may be summed up as follows:—Before the fall of dew the absolute moisture continues to increase and is greatest on the ground, diminishing with height. As soon as dew begins to fall, moisture decreases on the surface of the ground, and this decrease keeps pace with the decrease of temperature. The decrease of moisture extends upwards rather rapidly, and can be detected at four feet just after the first deposition of dew. On the ground the decrease per hour amounts to a maximum of about 0.73 mm., while half a foot above it the decrease only reaches 0.65 mm., which is less than one corresponding to the lowering of temperature. The higher the instrument the later does the decrease of moisture show itself, and the less the change per hour. It appears that owing to a fall of temperature on the ground, the air immediately above it becomes saturated, dew falls, and temperature and moisture diminish. At a certain point, owing either to diffusion or a descending current, fresh vapour supplies the place of that condensed as dew, and part of the loss of each stratum is successively made up by the moister stratum above it, but not the whole, for the diminution continues in all the strata. Time being required for the propagation of the decrease upwards, the lowest stratum loses more of its moisture than any of the strata above it.

Zeitschrift für Wissenschaftliche Zoologie, 1875. 2nd Supplement.—This part contains a memoir by Oscar Schmidt, on the embryology of calcareous sponges, in which Haeckel's observations and conclusions are attacked, and his Gastræa theory is destroyed, as far as calcareous sponges are concerned. Unfortunately, at a critical point Oscar Schmidt failed to follow his embryos, and the real purport of his observations remained uncertain until the publication of Schulze's researches hereafter mentioned.—Dr. William Marshall contributes a long memoir on the hexactinellid sponges, figuring and describing new species, with their characteristic spicula. His most interesting new form is one in which the central cavities of the spicula coalescing to form the meshes of the skeleton become perfectly continuous by their protoplasmic contents.

The 3rd Supplement (1875) commences with F. E. Schulze's memoir above referred to, on the structure and development of *Sycandra raphanus*. His beautiful figures give the various stages of segmentation, and the arrangement of the segmentation spheres into groups of different sizes, one set of these giving rise to the invagination by which the Gastrula form is constituted. This sponge is now accepted by Haeckel as exemplifying his Amphiblastic type, while other calcareous sponges form archiblastic embryos, in which the segmentation spheres remain similar to one another until after the Gastrula is formed.—August Weissmann contributes a philosophical paper on the transformation of the Axolotl into Amblystoma. He believes that this transformation is to be regarded as a retrogression, and that the present Axolotl represents a former Amblystoma whose structure has been modified by changed conditions of life.—Prof. Nitsche continues his valuable memoirs on the Bryozoa, the present instalment being devoted to the process of gemmation. He shows that all the structures in the new zooid are produced from the ectoderm of the parent, and insists on the important morphological consequences of this fact, while deprecating the precise schemes of embryogeny and phylogeny now so much in vogue.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 11.—On Simultaneous Barometric Variations in India, by J. A. Broun, F.R.S.—After Pascal showed that the mercury in the barometer tube stands lower at the top than at the foot of a mountain because the mass of air above the barometer is less in the former than in the latter case, it was a natural conclusion that the variations in the height of the mercury observed with a stationary barometer are due to the same cause. Various hypotheses have been proposed to explain how the aerial mass is increased or diminished, none of which, however, can satisfy the facts now known, being either insufficient or untrue. The author, after referring to the latest of these hypotheses, gives results which he has deduced from observations made at three stations in India; namely, at Simla, 7,000 feet above the level of the sea, on a spur of the Hima-

layas, at Madras, and at Singapore, near the sea-level, the last being 2,700 miles from the first, and 1,800 miles from the second station.

When the daily mean height of the barometer is taken, a large movement is found occupying nearly twenty-six days, a movement attributed by the author to the sun's rotation on his axis; but it is the smaller oscillations of the daily mean atmospheric pressure, the secondary maxima and minima, which are especially examined. The present discussion has been limited to three months, during which there were eighteen of these maxima and minima. The author finds that the mean interval between the times of maximum pressure at any two stations is less than seventeen hours, and between the times of minimum pressure less than ten hours. In four out of eight cases of minima the lowest pressure was attained at all the three stations within six hours. The results of these comparisons is shown to extend even to St. Helena.

It was pointed out that though in general maxima and minima happened at the three stations near the same hour, there were one or two marked exceptions to the rule; one of these, a fall in the height of the mercury of three-tenths of an inch within thirty-six hours, at Simla, was not perceived at any of the other stations. This, the greatest of all the disturbances of atmospheric equilibrium during the period examined, was shown to be connected with a great thunderstorm at Simla (not felt at the other places), and was thus due to a local cause, while the other variations, some of about one-thirtieth the amount of that just mentioned, happened nearly simultaneously over an area of at least a million square miles.

The author suggests that another cause is required to explain these facts than variations of mass through thermic or other actions, the whole climatic conditions being different at the various stations; in other words, *that the attraction of gravitation is not the only attractive force concerned in the variations of atmospheric pressure.*

Linnean Society, May 24.—Annual General Meeting.—Prof. Allman, F.R.S., president, in the chair.—There were presented by Mrs. J. J. Bennett, and a vote of thanks accorded, three medals, memorials of Linnaeus—one of silver, struck in 1746, given by Linnaeus to Haller in exchange for his portrait; one of gold, dated 1747, struck at the expense of Count Tessin; and a large silver one, designed by Lynberger, struck by command of the King of Sweden in commemoration of the death of Linnaeus, Jan. 10, 1778.—Mr. J. Gwyn Jeffreys, treasurer, read his statement of the accounts, &c., of the Society for the year 1875. These showed its financial position to be very favourable, and, indeed, prosperous. The increase in the number of Fellows was very marked, and everything augured the Society's retaining their well-earned reputation and usefulness as a scientific body.—The President then delivered his anniversary address, choosing as a topic the department of biology, treating of those remarkable forms, the border-land between vegetable and animal life. He began by allusion to De Bary's researches on Myxomycetes and its curious transformations; then referred in detail to Cienkowski's remarkable observations on Vampyrella and the marine sarcodous organisms, Labyrinthula. Dr. Archer's Chlamydomyxa, Haeckel's Myxastrum, and Magosphaerica, were each passed in review, and a comparison of all these forms entered into, with their peculiar phases and relations to each other. He observed that in them protoplasm was reduced to its simplest nature, evincing what might be considered vegetative or animal life, according to stage, &c. He summed up by regarding life as a property of protoplasm, but very different from conscience and will, or indeed any of the psychological phenomena. The following Fellows were elected into the Council:—J. G. Baker, Dr. W. P. Carpenter, Henry Lee, Prof. W. K. Parker, and S. J. A. Salter, M.B., in the room of the subjoined, who retired: W. T. T. Dyer, J. E. Harting, W. P. Hiern, M.B., Dr. J. D. Hooker, C.B., and J. J. Weir.

Chemical Society, May 18.—Prof. Abel, F.R.S., president, in the chair.—A paper on hemine hematine and a phosphorised substance contained in blood corpuscles, by Dr. J. L. Thudichum and Mr. C. T. Kingzett, was read by the latter.—Prof. W. N. Hartley then made a communication on the natural carbon dioxide from various sources, being a continuation and extension of his former paper on the presence of liquid carbonic anhydride in the cavities of quartz and other minerals.—Mr. Kingzett subsequently read a note on some trials of Frankland and Armstrong's combustion process *in vacuo*, by Dr. Thudichum and himself.—Mr. T. Fairley gave a short account of three papers in

peroxides, in which he described various reactions with hydrogen peroxide, and also the preparation of sodium and uranium peroxides, on chromic and perchromic acids, and on the estimation of nitrogen.—The Secretary read a paper, by Prof. J. W. Mallet, on aluminium nitride and the action of aluminium on sodium carbonate at a high temperature. The nitride forms small crystalline particles of a yellow colour.—Lastly, Mr. E. Neison gave a short account of a process for the estimation of mercury.

Royal Astronomical Society, May 12.—Mr. W. Huggins, president, in the chair.—The Rev. Frederick Howlett presented to the Society five volumes of sunspot drawings made between the years 1859 and 1874. They contain several drawings of sunspots on a large scale, some of which have already been figured in the pages of the *Monthly Notices*, and other places. A letter was read from Mr. Birmingham informing the Society that Dr. Schmidt's great lunar map of six French feet diameter will soon be issued by the Prussian Government. It has been the labour of thirty-four years, and contains 34,000 craters besides rills and other objects.—A paper by Mr. Dunkin was read on the conjunction of Venus with λ Geminorum, on August 18, 1876, when there will be an excellent opportunity for making micro-metrical measures of the planet's parallax with respect to the star. Its nearest approach will be seen from stations in North and South America a little before sunrise.—A paper by Mr. Hind was read on the transit of the great comet of 1819 across the sun's disc. The transit happened on its approach to perihelion, and the comet was not observed until some days afterwards, when it was receding from the sun. After a few weeks Olbers calculated the elements of its orbit, and announced the fact that on the previous 26th of June it must have passed at its ascending node between the earth and sun. Some five years afterwards Pastorf wrote to the Baron de Zach to inform him that he had seen the comet upon the sun's disc, and had, upon the day of its transit, made a drawing of it and a measure of its distance from the sun's limb. He describes it as a nebulous body 6' in diameter with a bright centre. His original drawing is preserved in the library of the Astronomical Society. Mr. Hind has carefully recalculated the elements of the comet's orbit, and has found that at the time mentioned by Pastorf the comet must have appeared much nearer to the sun's centre than the position indicated by Pastorf. Canon Stark of Augsburg, also published an account of a nebulous body seen upon the sun's disc at 7h. 5m. on the morning of June 26. The measures given by him of the position of the black spot do not agree with the position calculated by Mr. Hind, although there is less discrepancy between them and the calculated position than there is in the case of Pastorf's observation. Mr. Hind is disposed to think that neither Stark's nor Pastorf's observations are to be depended upon.—Mr. Christie read a note on the displacement of lines in the spectra of stars, from which it appeared that the discrepancies between the results of his observations and those of Mr. Huggins only amounted in the case of most of the stars which had been given by him to some three or four miles per second. The meeting adjourned till June 9.

Geological Society, May 24.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—The following communications were read:—"On the old glaciers of the northern slope of the Swiss Alps," by Prof. Alphonse Favre. The author said that in existing glaciers two parts may be recognised,—an upper one, the reservoir or feeding glacier, and a lower one, the flowing glacier. Applying this division to the old glaciers, it appears that in the glaciers of the Rhone and Rhine the flowing glacier which occupied the plain had a surface nearly equal to that of the feeding glacier which was situated in the mountains. He showed (1) that the Rhone glacier passed over several of the chains of the Jura, and that the ice covering these, far from being an obstacle to the extension of the glaciers of the Alps, actually reinforced them, and served them as *relays*, the glaciers of the Jura having carried far on the Alpine erratic blocks; (2) that the slopes of the upper surface were variable, and were null, or nearly so, over considerable spaces. During their greatest extension the Swiss glaciers came in contact with those of central France near Lyons; they united with those of the Jura, the Black Forest, and the Austrian and Italian Alps; they stretched from the plain of the Po to that of the Danube; and further, for distances of 50 or 100 kilometres they nearly approached horizontally. Hence they resembled the glaciers of the interior of Greenland and Spitzbergen, so far as can be judged from the descriptions.—Evidences of Theriodonts in Permian deposits elsewhere than in South Africa, by Prof. R. Owen, F.R.S. In

this paper the author noticed some described reptilia which he believes to belong to his order Theriodontia. The genus *Eurosaurus* was founded in 1842 by Fischer von Waldheim upon some fragments of bone, including a humerus with a broad proximal end as in Kutorga's *Orthopus*; and Fischer also noticed a humerus showing characters like those of Kutorga's *Brithopus*, from the same locality as the portion of a jaw described under the name of *Rhopalodon Wangenheimii*, Fischer. In 1858, H. von Meyer described a skull from the Permian of the Oural, under the name of *Mecosaurus uralensis*, as a Labyrinthodont; and Eichwald referred this genus, with Kutorga's *Brithopus* and *Orthopus*, to Fischer's *Eurosaurus*. The author regarded *Mecosaurus* as truly Labyrinthodont; whilst the Permian forms constituting Kutorga's genus were referred to the Theriodont order. From the same locality as the above Kutorga describes *Syodon biarmicum* as probably a Pachyderm. Its teeth resemble those of *Cynodraco*. Eichwald's *Deuterosaurus biarmicus* is founded upon the fore part of both upper and lower jaws of a reptile, containing teeth with denticulate or crenulate trenchant borders, the canines being large, especially in the upper jaw. *Deuterosaurus* closely resembles *Cynodraco*, and still more the *Lycosaurus* of the Karoo beds of the Sneewberg range. All the above are from the Permian beds of the Oural, and the author regards them as furnishing important evidence of the Palaeozoic age of the Karoo series, in which the Theriodont reptiles are best represented. The author further noticed a Theriodont allied to *Lycosaurus* from a red sandstone, probably of Permian age, in Prince Edward Island. The remains include the left maxillary, premaxillary, and nasal bones; the teeth, implanted in distinct sockets, have sub-compressed, re-curved, conical, pointed crowns, with minutely crenulated borders. This fossil has been described by Dr. Leidy under the name of *Bathynathus borealis*. Thus, supposing the affinities of the fossils from the Oural and Prince Edward Island to be correctly determined, the reptilia distinguished by mammalian characters are shown to have had a very wide range. Further, the author thinks that the Theriodont reptiles of the Bristol Dolomite conglomerate may also prove to constitute a family in the Theriodontic order.

Physical Society, May 27.—Prof. Gladstone, vice-president, in the chair.—The following candidates were elected members of the Society:—Herbert Taylor, Rogers Field, and Channell Law.—Mr. W. Ackroyd read a paper on selective absorption. Two typical experiments were shown upon which a division of selective absorption may be based. In the first, light is transmitted through bichromate of potash at the normal temperature and again at about 200° C.; and the spectrum of the transmitted light is examined. The widening of the absorption-bands which takes place at the higher temperature is traced to structural alterations. In the second experiment light is sent through two thicknesses of the same coloured solution, as, for example, sulphate of copper, and in the greater thickness the absorption-band has widened out, but this is plainly not owing to any structural alteration. That in the first experiment he proposes to term *structural*, and that in the second *transverse* absorption, and he considers that these two kinds have not hitherto been sufficiently distinguished. Certain colour relations which exist among anhydrous binary compounds led the author to the conclusion that the width of a structural absorption-band bears a direct relation to interatomic distance. The necessity for separating high temperature spectra from low was shown, and the bearing of the subject on the study of organic colouring matters briefly alluded to.—The Secretary then read a communication from the Rev. R. Abbay, on certain remarkable atmospheric phenomena in Ceylon. The most striking of these is witnessed from the summit of Adam's Peak, which is a mountain rising extremely abruptly from the low country to an elevation of 7,200 feet above the sea. The phenomenon referred to is seen at sunrise, and consists apparently of an elongated shadow of the mountain projecting westward to a distance of about seventy miles. As the sun rises higher it rapidly approaches the mountain and appears at the same time to rise before the observer in the form of a gigantic pyramid of shadow. Distant objects may be seen through it, so that it is not really a shadow on the land, but a veil of darkness between the peak and the low country. It continues to rapidly approach and rise until it seems to fall back upon the observer, like a ladder which has been reared beyond the vertical, and the next instant it is gone. Mr. Abbay suggests the following explanation of the phenomenon:—The average temperature at night in the low country during the

dry season is between 70° and 80° F. and that at the summit of the peak is 30° or 40° F.; consequently the low strata of air are much the less dense, and an almost horizontal ray of light passing over the summit must be refracted upwards and suffer total internal reflexion, as in ordinary mirage. On this supposition the veil must become more and more vertical, as the rays fall less horizontally, and this will continue until they reach the critical angle, when total internal reflexion ceases and it suddenly disappears. Its apparent tilting over on the spectator is probably an illusion, produced by the rapid approach and the rising of the dark veil without any gradual disappearance which can be watched and estimated. It will be evident that the illumination of the innumerable particles floating in the atmosphere causes the aerial shadow to be visible by contrast. Another interesting phenomenon visible in the mountain districts admits of an equally simple explanation. At times broad beams apparently of bluish light may be seen extending from the zenith downwards, converging as they approach the horizon. The spaces between them have the ordinary illumination of the rest of the sky. If we suppose, as is frequently the case, that the lower strata of air are colder than the upper, the reflexion spoken of in the case of Adam's Peak will be downwards instead of upwards. If several isolated masses of clouds partially obscure the sun, we may have several corresponding inverted veils of darkness like blue rays in the sky all apparently converging towards the same point below the horizon. This latter phenomenon is called by the natives "Buddha's Rays."—Prof. Dr. Forel of Morges, Switzerland, then gave, in French, an account of some interesting observations which he has recently made on the periodic waves which take place on the Swiss lakes and are there called "Seiches." It was long since observed that the waters of most of these lakes are subject to a more or less regular rise and fall, which at times have been found to be as much as one or two metres. M. Forel has studied this phenomenon in nine different lakes, and finds that it varies with the length and depth of the lake and that the waves are in every way analogous to those already studied by Prof. Guthrie in artificial troughs, and follow the laws which he has deduced from his experiments. Most of the observations in Switzerland were made on the lake of Geneva, but that of Neuchâtel was found to be best fitted for the study of the subject, possessing as it does an extremely regular geometric form. The apparatus he employed was very sensitive to the motion of the water, being capable of registering the waves caused by a steamboat half an hour after it had passed, and five minutes before its arrival, and was so constructed as to eliminate the effect of common waves, and to register the motion side by side with a record of the state of the barometer, on paper kept in continuous motion. While he found the duration of waves to be ten minutes at Morges it was seventy minutes at Geneva, and this is explained by the narrowness of the neck of the lake at the latter place. This period he proved to be independent of the amplitude, and to be least in the shortest lakes. For shallow lakes the period is lengthened and his observations show that the period is a function of the length and depth and that longitudinal and transverse waves may coexist, just as Prof. Guthrie has shown to be the case in troughs.

STOCKHOLM

Academy of Sciences, March 12.—Herr Rubenson communicated a paper entitled "Monthly and yearly averages of Temperature at the State Meteorological Stations during the Years 1859-1872."—Herr Smitt gave an account of a visit paid by Herr P. Olsson, assisted by a grant from the Academy, to Norrland for zoological research.—Herr Th. M. Fries gave an account of two reports made to the Academy—one by Docent Berggren, who had gone to New Zealand for the purpose of studying its flora, and the other by Dr. Hellbom, who had made a lichenological visit to Norrland.—The following papers were communicated:—On the influence of inequalities with long period on the expression for the absolute perturbations of periodic comets, by Herr Gyldeán.—Narrative of an expedition to Novaya Zemlya and the mouth of the Jenisei in 1875, with map, by Prof. Nordenskjöld.—On the simultaneous covariants of the fourth order and fourth class of two conic sections, by Prof. Björling.—On sulphonaphtholide, by Prof. Cleve.—On the action of pentachloride of phosphorus on β naphthol, by Prof. Cleve and Candidate Julin-Dannfelt.—On the estimation of nickel in nickelferous magnetic pyrites, by Herr Ekelund.—Contributions to the knowledge of the development of Rajae, by Intendent Malm.—Contributions to the Orthopter-fauna of South Africa, by Prof. Stål.

PARIS

Academy of Sciences, May 29.—Vice-Admiral Paris in the chair.—The following papers were read:—On the atomic constitution of bodies, by M. de Saint-Venant. There is nothing contradictory in regarding atoms as material points having all the properties of visible and tangible bodies, less extension.—New remarks on the real existence of a matter formed of isolated atoms comparable to material points, by M. Berthelot. He gives reasons for withholding assent to MM. Kundt and Warburg's view.—On the salts formed by peroxide of manganese, by M. Frémy.—Observations on a basking shark recently caught at Concarneau, by MM. Gervais. This species (*Squalus maximus*) is found but rarely in temperate waters. It has a number of flexible, elastic filaments (of osseous nature) attached to the branchiae; these sift the water, retaining the small animals as food.—Examination of the possible mechanical action of light. Study of the radioscope of Mr. Crookes, by M. Leduc. The author's theory (implying a special action of polarised light) was submitted to the test of experiment by M. Fizeau, but with negative results. Further experiments are promised.—The Caucasus and its mineral waters, by M. François.—Intensity of gravity in the island of St. Paul, by M. Cazin. The apparent acceleration of gravity there exceeds the theoretical acceleration by $\frac{1}{5000}$ of its value. May not this affect astronomical observations?—On the radiometer of Mr. Crookes, by M. de Fonvielle. He describes experiments, whence he infers an impulsive action of light. M. Fizeau says that if a bundle of solar rays fall on the instrument, limited by a screen so that they strike only the polished surfaces, the rotation is such that each vane comes to meet the rays instead of escaping from them, as would be the case if the light had impulsive force.—On the Phylloxera of the leaves of the French vine, by M. Delachanal.—On the laws of matter, by M. de Marsilly.—On a compressed air filter for water, by MM. Chanoit and Midoz.—On the transformation of elliptic functions, by M. Laguerre.—On the development in series of the functions $Al(x)$, by M. Joubert.—On the charge taken by the disc of the electrophorus, by M. Douliot. He describes an arrangement by which he verified the theoretical conclusion that the charge of the discs proportioned to its radius.—Theory of spectra; observations on Mr. Lockyer's last communication, by M. Lecoq de Boisbaudran. All spectral lines change in relative intensity when the temperature is raised; Mr. Lockyer's theory would imply that each element is decomposed into as many more simple substances as its spectrum has lines. Considering the immense number of lines in certain spectra, such a view seems little probable.—On the constitution of prophylenic monochlorhydrines, and the law of addition of hypochlorous acid, by M. Henry.—On a quinoacetate of calcium, by M. Gundelach.—Variations of the electric state of the muscles in voluntary contraction and artificial tetanus, studied with the aid of the galvanoscopic limb, by MM. Morat and Toussaint.—Anaesthesia by the method of intravenous injections of chloral; amputation of the thigh; absolute insensibility; consecutive sleep for six hours; cure without any accident; by M. Oré.—On frauds met with in the points of lightning conductors, by M. Francisque Michel.

CONTENTS

	PAGE
BRITISH MANUFACTURING INDUSTRIES. By T.	145
HUTTON'S "GEOLOGY OF OTAGO."	146
OUR BOOK SHELF:—	
Munn's "Elementary Algebra"	147
LETTERS TO THE EDITOR:—	
The Early History of Magnetism.—WM. CHAPPELL	147
The Dry River-beds of the Riviera.—JOHN AITKEN	148
Method of Distributing Astronomical Predictions.—CHARLES DE LITTROW	149
Acoustical Phenomena.—J. P. THOMPSON	149
Great Tertioles.—DR. SAMUEL HAUGHTON, F.R.S.	149
Photography of Loan Collection Apparatus.—L. B.	149
ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE. By DR. BENJAMIN W. RICHARDSON, F.R.S.	149
OUR ASTRONOMICAL COLUMN:—	
The Comet of 1698	152
The Binary Star α Leonis	152
Variable Stars	152
The Double-star γ Centauri	152
THE MAMMALS AND BIRDS OF BURMA	153
METEOROLOGY AT MELBOURNE	153
AMERICAN-INDIAN STONE TUBES AND TOBACCO-PIPES. By DR. CHARLES C. ABBOTT (With Illustrations)	154
NEW METEOROLOGICAL OBSERVATORIES AT MONTSOURIS. By W. DE FONVIELLE	156
NOTES	157
LOAN COLLECTION OF SCIENTIFIC APPARATUS—	
Section.—Mechanics.—Prime Movers	159
SCIENTIFIC SERIALS	161
SOCIETIES AND ACADEMIES	168

t
t
t
7
f
—
11
15
16
17
17
18
19
19
19
19
49
52
52
52
52
53
53
54
56
57
59
61
62